EVALUATION OF HYDROPOWER PROJECTS AND IDENTIFICATION OF POTENTIAL OPPORTUNITIES FOR POLLUTANT TRADING

FINAL REPORT

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May 7, 2001

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EXECUTIVE SUMMARY

The Environmental Protection Agency (EPA) funded a study of water quality at hydropower projects in the Mississippi River Basin (MRB). This exploratory analysis focused on organic enrichment/low dissolved oxygen, nutrients, thermal modifications, flow alterations, and ammonia conditions. The study also evaluated what role, if any, that pollutant trading could play in improving reservoir water quality and the quality of releases from hydropower projects in the Mississippi River Basin.

The study identified 55 hydropower projects with 289 "total maximum daily loads" (TMDL's) that could benefit from a watershed based trading program. It was also found that TMDL conditions were not restricted to any particular size of hydropower projects and the majority of the TMDL sites were found upstream of the dam. Thirty-five of the hydropower projects were identified as "high volume" projects with reservoirs containing more than 103,813 acre-feet of storage capacity. The other candidate sites were equally divided between "moderate" and "low volume" projects, i.e., projects containing less than 103,813 acre-feet of storage but more than 3,967 acre-feet of storage (moderate volume), or less than 3,067 acre-feet of storage (low volume).

An evaluation of the available information for the 31 MRB states indicated that

(1) 14 MRB states had 1 or more TMDL sites that were associated with a hydropower project,
(2) 10 MRB states did not identify a TMDL site near a hydropower project, and
(3) 7 states in the MRB did not have hydropower projects located on tributaries draining into the Mississippi River.

Of the states with candidate trading projects, Tennessee had the most projects (11) followed in descending order by Oklahoma (10), Illinois (10), Iowa (5), Alabama (4), Montana (4), Missouri (3), Kentucky (2), Nebraska (2), Minnesota (2), Ohio (1), and Wisconsin (1).

The most often cited water quality concern was nutrients. They contributed to impaired water quality 40 % of the time. Organic enrichment/low dissolved oxygen was identified 32 % of the time followed by flow alteration (11 %), ammonia (10 %), thermal modification (5 %), and un-ionized ammonia (2 %). Non-point sources of pollution were identified as the major contributor to the problems reported. They were present 88 % of the time. The nonpoint category and its relative frequency of occurrence, in descending order, were agricultural nonpoint sources (46 %), hydromodifications (19 %), land development activities (16 %), urban runoff (10 %), and other (9 %).

The initial findings of this study indicate that hydropower projects and their upstream reservoirs are being adversely affected by pollutant loading from the upstream watershed. And, these pollutant loads in conjunction with reservoir processes and the location of turbine intakes can contribute to poor quality hydro-turbine releases. It was also noted that these projects have the potential to make a significant contribution to national water quality objectives if technological advances to improve water quality in reservoirs, downstream tailwaters, and hydro-turbine releases are employed in a watershed based trading program. By linking hydropower projects, TMDLs, and pollutant trading it may be possible to create a new paradigm where water quality can be enhanced and project owners reimbursed through pollutant trading.

Introduction

On March 16, 1995 President Clinton unveiled a new initiative entitled "Reinventing Environmental Regulations" EPA, 1995) which laid out a program to find "New and innovative ways to achieve greater levels of environmental protection at a lower cost" (emphasis added). It emphasized flexibility, pollution prevention, collaboration, cooperation, responsibility and accountability in implementing the program. It also established a national goal for a "21st Century America in which economic incentives, environmental incentives and technological innovations are aligned so that economic growth improves rather than diminishes environmental quality".

To accomplish the President's program, the Environmental Protection Agency (EPA) was charged with giving priority to watershed based pollutant trading, among other things, where traditional technology based treatment requirements have not achieved water quality objectives. This report examined one aspect of pollutant trading, i.e., the possibility of including hydropower projects in a watershed based trading program. In doing so, it recognized the importance of recent technological innovations and multi-objective reservoir operational models that have been developed by the hydropower industry to improve water quality at water resource projects (EPA, 1993; TVA, 1981,1983, 1984,1996; and March and Fisher, 1999).

This report focused on "water quality limited stream reaches" in the Mississippi River Basin (MRB) that have been identified by the states under section 303(d) of the Clean Water Act. This project focused on the MRB because of water quality concerns within this watershed and their contribution to the hypoxia problem in the Gulf of Mexico. By including hydropower projects in a pollutant-trading program it may be possible to:

(1) Achieve State and Federal water quality standards.
(2) Enhance water quality in reservoirs by reducing pollutant loads coming into the reservoirs.
(3) Maximize other water resource benefits at projects where the value for power generation is marginal.
(4) Provide for additional economic growth where current downstream waste assimilative capacity in the stream is limited.
(5) Enhance river habitats for recreation and fishing.
(6) Provide a new source of revenue for hydropower projects through the sale of pollutant credits.

The precedent for this proposal was an exploratory analysis of the Holston River near Kingsport, Tennessee (Podar, et al, 1985) and subsequent publications on efforts to improve water quality in the Tennessee Valley (Crossman, 1986, 1988, 1997, 1998). The study involved a heavily developed stream segment downstream of the Tennessee Valley Authority's (TVA) Fort Patrick Henry Dam. Stakeholders included the state of Tennessee, city of Kingsport, local industries, Trout Unlimited, and the Tennessee Conservation League. With the concentrated land development along the stream, in-stream water quality standards were seldom met, even after the city and other dischargers built new waste treatment facilities and met their technology based discharge requirements.

Water flow in the river was also highly variable. The river channel was full when TVA released water to generate power during morning and evening hours, when demand for electricity was high. During non-generating periods, however, the volume of water in the river dropped precipitously. The combination of concentrated development and variable flows resulted in poor in-stream water quality. Water quality, in fact, was so bad that the state declared the stream "water quality limited." This designation threatened to limit economic growth for existing industries and for others wanting to locate in the area, unless they were willing to forego any discharge. In addition, two fisheries in the area were threatened. The first was a highly prized "put and take" trout fishery just downstream of the dam. The second was a smallmouth bass fishery where the South Fork Holston joined the North Fork Holston, 13 km (8 miles) downstream.

The analysis focused on a point/nonpoint trading scenario where the dam was considered a nonpoint source. The various options considered were advanced waste treatment systems for the point source dischargers, turbine aeration at Fort Patrick Henry Dam, in-stream aeration, flow augmentation options, and a combination of higher flows and aeration – all of which are summarized in Table 1. During the study, the minimum daily flow below the dam was 750 cubic feet per second (cfs) and the minimum dissolved oxygen (DO) concentration in the turbine discharges was 3.0 mg/l.

Table 1. Comparison of options to increase DO in the Holston River (1997 $'s).*

Treatment Options	Minimum 6 hr average, (mg/l)	Minimum Daily average, (mg/l)	Annual Costs, ($1000's)
Effluent Management Methods			
adv. waste treatment, discharge 5700 lb/day	1.9	3.3	43,900
adv. waste treatment, discharge 8200 lb/day	1.6	3.0	5,800
River Management Methods			
flow augmentation, 875cfs	2.0	3.6	69
flow augmentation, 1000 cfs	2.8	4.3	181
flow augmentation, 1125 cfs	3.3	4.6	312
in-stream aeration, one location, 15 days/yr	1.9	3.6	132
in-stream aeration, two locations, 128 day/ yr	2.0	4.6	297
flow augment, 875 cfs; DO 6.0 mg/l at dam	2.3	3.9	137
flow augment, 1,000 cfs; DO 6.0 mg/l at dam	3.0	4.6	249
flow augment, 875 cfs; DO 8.0 mg/l at dam	2.4	4.3	186
flow augment, 1,000 cfs; DO 8.0 mg/l at dam	3.3	4.9	298
flow augment, 1,000 cfs; inst. aeration, one location, 15 days/yr	3.3	4.4	207
flow augment, 1,125; DO 6.0 mg/l at dam	3.4	5.0	395
flow augment, 1,000; DO 6.0 mg/l at dam; inst. aeration, one location, 15 days/yr	3.8	5.3	375

- Reproduced from Ruane, Crossman, and Hauser, "Hydrovision 98 Conference", 1998.

Computer modeling indicated that the state's dissolved oxygen standard of 5.0 mg/l could not be attained with additional advanced wastewater treatment. The only way to achieve the standard was to increase the flow through the dam from 750 cfs to 1,000 cfs, improve DO in hydro-turbine releases to 6.0 mg/l, and provide periodic instream aeration at one site in the stream. The 1,000 cfs flow option could be accomplished by turbine pulsing and aeration could be accomplished through turbine venting. The estimated cost was approximately $300 – $400,000 (1997 dollars) which was nearly two orders of magnitude less than the cost of the most advanced wastewater treatment option which cost $44 million a year (Table 1). Moreover, increasing dissolved oxygen (DO) and minimum flows at the dam resulted in higher DO concentrations than could be achieved when industrial and municipal discharges eliminated all oxygen demanding wastes from their discharges.

The trading scenario just described would be considered a "Facility Trading Option". That is, it involves a hydropower project and a water quality limited downstream reach. And, it would only be considered where downstream point sources were in compliance with their national pollutant discharge elimination system permit requirements. Pollution credits would be created when hydropower releases were aerated to exceed state standards for DO and the increment of improvement above the standard could be marketed to downstream clients.

The second alternative would be a "Watershed Trading Option" and would involve the dam, the upstream reservoir, and the watershed. It would require a cooperative effort between point sources, nonpoint sources, and the hydropower owner to identify, develop, and implement cost effective ways to reduce pollutant loads coming into the reservoir, thereby, improving reservoir water quality, assimilative capacity, and the quality of hydropower releases. Possible trading opportunities would include point/point, nonpoint/point, and nonpoint/nonpoint trading within the watershed.

Data Evaluation and Analysis

The EPA/States TMDL database was queried to identify TMDL sites near hydropower projects. This was accomplished by developing a protocol to merge the TMDL "Causes" database with the TMDL "List ID" database (Appendix 1). Following the merger of the databases, "indicator causes" were selected and used to query the consolidated database. The TMDL "indicator causes" were "organic enrichment/low dissolved oxygen, nutrients, thermal modification, flow alterations, and ammonia". The resulting list was further reduced by a third screening step that emphasized the proximity of the TMDL site to a hydropower project. The process used information contained in USGS State Hydrologic Unit Maps, the **National Water Quality Inventory, 1996 Report to Congress** (EPA, 1998), other map sources, and the **National Inventory of Dams** to reduce the 6,296 TMDL files to 289 TMDL files and 55 "candidate trading sites" (Appendix 2). The candidate project list was also merged with the TMDL "Sources" database to create a state project listing (Appendix 3). Descriptions of the candidate trading projects are contained in Appendix 4 and are grouped according to sub-basin, i.e., Upper Mississippi, Lower Mississippi, Arkansas/White/Red, Missouri, Ohio, and Tennessee.

The U.S. Army Corps of Engineers' (USACE) **National Inventory of Dams** database identified an estimated 29,629 dams in the 31 Mississippi River Basin states. After downloading the projects, they were screened and those hydropower projects with either a hydraulic height equal to or greater than 15 feet and/or a normal storage capacity greater than 1000 acre-feet were selected for further consideration. The hydropower projects considered are listed in Appendix 5 which contains the following information in a spreadsheet format:

Dam Name -- The name of the hydropower project and the name of the lake if they are different (when this information was available).

River -- Name of the river on which the project is located.
City -- The city near the project.
Owner -- The owner of the hydropower dam. (DAEN refers to the U.S. Army Corps of Engineers, and letters following DAEN refer to various Corps Districts.)
Purpose -- The recognized purpose for which the project was built. The codes used are: H – Hydroelectric, C – Flood Control and Storm Water Management, N – Navigation, S – Water Supply, I – Irrigation, R – Recreation, F – Fish and Wildlife. The codes are concatenated if the dam has multiple purposes.
Hydraulic Height (HYDR_HGT) -- The hydraulic height of the dam in feet. It is defined as the vertical difference between the maximum designed water level and the lowest point in the original streambed.
Normal Storage (NORM_STOR) -- The amount of water storage in the reservoir in acre-feet when the pool level is within the normal rage of elevation.
Surface Area (SURF_AREA) -- The surface area of the upstream impoundment or reservoir in acres.
Drainage Area (DRAIN_AREA) -- The number of square miles of the drainage area upstream of the dam.
HUC NUMBER -- The USGS hydrologic unit code for the watershed in which the dam is located.

The hydropower projects in each state were also grouped according to volume using the classification scheme developed for the 'Hydrologic Modification Caused by Dams 1995-1996' section of the **Index of Watershed Indicators** (EPA, 1997). The classification recognized three categories.

(1) Low Volume of Impounded Water (Impoundment Contains < 3,967 Acre-Feet (ac-ft))
(2) Moderate Volume of Impounded Water (Impoundment Contains >3,967 ac-ft but < 103,813 ac-ft)
(3) High Volume of Impounded Water (Impoundment Contains >103, 813 ac-ft)

To facilitate this analysis, the data were hierarchically organized by hydropower project, TMDL site, and TMDL file. For example, the J. Percy Priest Hydro Project in middle Tennessee was associated with 2 TMDL sites and 3 TMDL's. The first site extended from the confluence of the Stones River with the Cumberland River upstream to J. Percy Priest Dam. The site had two TMDL files for (1) flow alteration and (2) organic enrichment/low DO that were attributed to poor water quality in the releases from the dam. The other site was upstream of the reservoir on the West Fork Stones River. This site had one TMDL file that identified organic enrichment/low DO from "development impacts around the Old Fort Parkway and Murfreesboro sewage treatment plant".

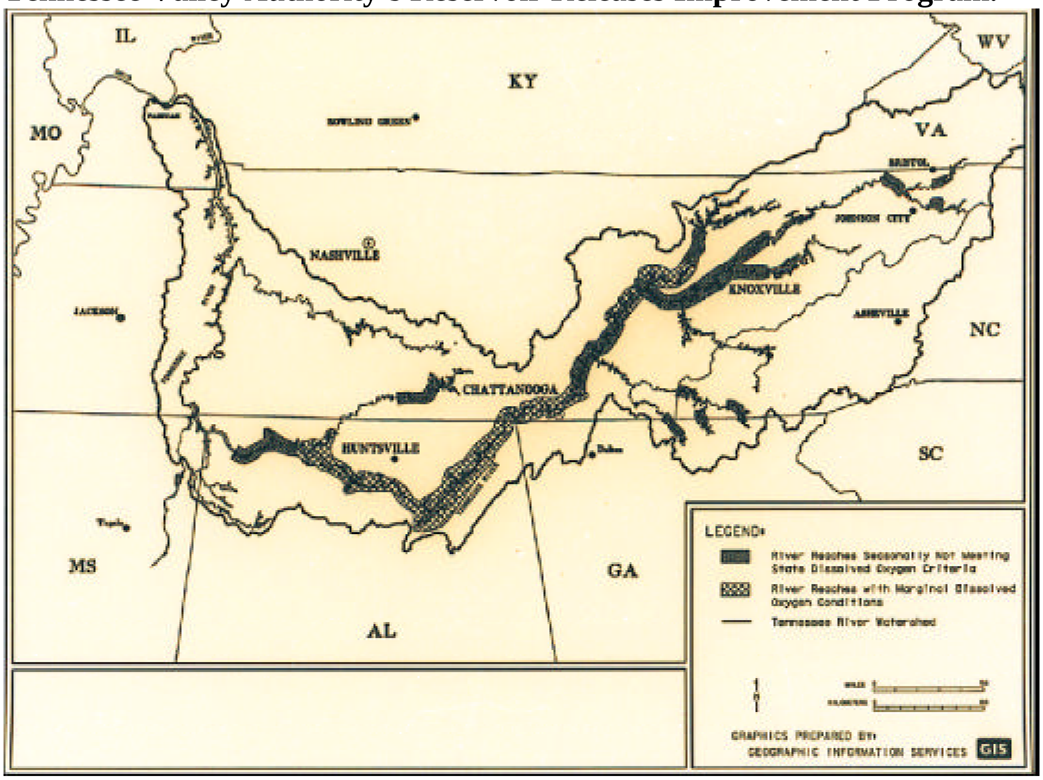
Discussion and Results

Tennessee Valley Experience

In the late 1970's the Tennessee Valley Authority (TVA) recognized that its dams were having an adverse impact on downstream water quality and uses. Dissolved oxygen (DO) concentrations in hydro-turbine releases in combination with peaking power operations often failed to meet water quality standards and downstream assimilative capacity was severely diminished (Figure 1). TVA's efforts to improve this situation involved a multi-faceted technological and resource management approach. Over a 10-

year period, TVA's staff developed a series of inexpensive, efficient aeration and flow options that could be readily implemented. They also undertook measures to reduce pollutant loads from TVA facilities and properties owned around its reservoirs. The agency also undertook, in concert with the Valley states, major demonstration projects to reclaim abandoned mine lands and control agricultural and silvacultural soil erosion.

Figure 1. Map of the Tennessee River Basin identifying low DO conditions and marginal waste assimilative capacity before the implementation of the Tennessee Valley Authority's Reservoir Releases Improvement Program.



In 1991 the Tennessee Valley Authority's (TVA) Board of Directors approved a 5-year plan to improve dissolved oxygen (DO) and provide minimum flows downstream of 16 TVA dams that were contributing to poor water quality in the TVA system. This voluntary $43 million program was completed on time and within budget. A summary of the technologies employed, DO improvement, stream miles affected, capital costs, and the 303(d) status of each project can be found in Table 2. A seasonal DO standard of 4.0 mg/l or higher was achieved in over 300 miles of stream and assimilative capacity was enhanced in another 700 miles. However, as noted in TVA's testimony before the congressional subcommittees that were holding hearings on the reauthorization of the Clean Water Act, nonpoint sources of pollution were and continue to be a pervasive water quality problem in the Tennessee Valley (TVA, 1985). And, it was felt that the quality of releases from dams could be improved above a seasonal DO concentration of 4.0 mg/l if the nonpoint loads to TVA's reservoirs could be reduced.

Table 2. Technologies used by the Tennessee Valley Authority to improve dissolved oxygen concentrations and assimilative capacity at hydropower projects experiencing seasonal water quality problems, June 2000.

Project	Turbine(s) (#)	Current Aeration Technologies (1)	Dissolved Oxygen Improvement (mg/l)	Impact Range (miles)	Capital Cost ($'s x$10^6$)	303(d) Listing
Apalachia	2	TV,VBBC	2	2	0.1	No
Boone	3	TV,VBBC	2	10	0.2	No
Chatuge	1	IAW	6	7	1.4	No
Cherokee	4	FOD,SWP,TV	4	50	5.0	Yes
Douglas	4	FOD,SWP,TV	4	80	5.0	Yes
Fontana	3	TV,VBBC	2	5	0.2	No
Hiwassee	1	FOD	1.5	3	3.0	No
Norris	2	AVT	5	13	3.0	No
Nottely(2)	1	FAT,VBBC	4	3	1.5	No
Tims Ford	1	FAT,POD	6	40	1.5	Yes
Watauga	2	TV,VBBC	2	2	0.1	Yes
Watts Bar	5	SUO,FOD	1	30	1.3	No
Blue Ridge(2)	1	FOD	3	15	0.7	No
Ft. Patrick Henry	2	UPI(3)	-	5	-	Yes
Ft. Loudoun	4	SUO,FOD	1-2	42	1.5	Yes
South Holston	1	TV,VBBC,LAW	6	6	1.9	Yes
Total(s)	37	-	-	313	26.4	-

(1). AVT=Auto Venting Turbine, FAT=Forced Air Turbine, FOD=Forebay Oxygen Diffuser, POD=Penstock Oxygen Diffuser, SWP=Surface Water Pump, IAW=Infuser Aerating Weir, LAW=Labyrinth Aerating Weir, SUO=Selective unit operation, UPI=Upstream Project Improvement, VBBC=Vacuum Breaker Bypass Conduit
(2). Project also includes a small, minimum flow turbine.
(3). DO improvement at Ft. Patrick Henry was accomplished by aerating at upstream projects, i.e., Boone, South Holston, and Watauga.

As indicated in Table 2 it is possible to improve water quality in hydropower releases. However, based on the TVA experience, a systems or watershed based approach is recommended to improve and protect water quality at water resource projects. And, the solution to improved DO and flows at each project is highly site specific and dependent on a number of factors that include, but are not limited to the following:

- Severity of the Problem – For example, anaerobic conditions resulting in the formation of anoxic byproducts such as hydrogen sulfide, ammonia, etc. or low DO (1.0- 2.0 mg/l); frequency, extent, and duration of water quality problems; condition of tailwater fisheries, etc.
- Project Setting – Tributary vs. main stem project; high head vs. low head dam; upstream structures such as submerged weirs or other features that might affect water quality in the turbine discharge; proximity and type of downstream development; extent and type of upstream development; shoreline condition, etc. It is also important to know the type and rate of discharge to the downstream reach, i.e.,

whether the hydro-turbine release is to a stream environment or an impounded, slack water environment.

- Project Purpose – Single purpose or multi-purpose, public vs. privately owned dam.
- Type of Turbine - Francis Turbine, Kaplan Turbine, Modified Unit, etc.
- Hydraulic residence time and pressure of water in the turbine system downstream from the turbine runner.
- Upstream Reservoir Characteristics - Normal storage area, surface acreage, drainage area, reservoir depth, stratification (onset and duration), quality of inflows, retention time, presence of macrophytes and/or algal blooms, etc.

Using the site-specific information gathered at each project in the TVA system, 8 different solutions were developed to improve water quality at projects experiencing problems (Table 2). They varied from auto venting turbines to a vacuum breaker bypass conduit. While most of the solutions involved the installation of new equipment and/or structures, two solutions involved non-structural alternatives, i.e., selective unit operation and improved water quality due to improved inflows from an upstream project. Whatever the solution, when TVA completed work on its Reservoir Releases Improvement Program, water quality, recreation, fisheries, and economic development opportunities were enhanced in over 1,000 miles of the TVA system.

Mississippi River Basin Study

In the initial screening of the MRB database, 55 hydropower projects (hydro's) and 181 TMDL sites were identified as potential candidates for pollutant trading. The number of hydropower projects, TMDL sites, and TMDL files per state are presented in Table 3. There were 14 MRB states with 1 or more candidate trading projects. The states with candidate trading projects are Alabama, Iowa, Illinois, Kentucky, Minnesota, Missouri, Montana, Nebraska, Ohio, Oklahoma, Tennessee, and Wisconsin. The other 19 MRB states either did not have a TMDL site near a hydropower project or there were no hydropower projects located on tributaries draining into the MRB. The seven MRB states without hydropower projects in the basin are New Mexico, Texas, New York, Michigan, Maryland, Mississippi, and Louisiana.

Of the 12 states with candidate projects, Tennessee had the most hydropower projects (11) followed by Oklahoma with 10 projects. Tennessee's 11 projects are located throughout the state and are government owned. Seven of the projects are owned and operated by the Tennessee Valley Authority (TVA), i.e., Fort Patrick Henry, Cherokee, Watauga, Douglas, Fort Loudoun, Tim's Ford, and Kentucky. The other 4 hydro's – Center Hill, Old Hickory, J. Percy Priest, and Cheatham -- are owned by the U.S. Army Corps of Engineers (USACE) and operated by a consortium led by TVA. These projects had a total of 21 TMDL sites. The number of TMDL sites varied from 1 site at Fort Patrick Henry, Cherokee, and Kentucky hydropower projects to a maximum of 4 sites associated with Center Hill Hydro. The number of candidate hydropower projects found in each state and the number of associated TMDL sites and files is summarized in Table 3.

Table 3. Summary of the hydropower projects, TMDL sites, and TMDL files for candidate pollutant trading projects in the Mississippi River Basin, June 2000.

State	Hydro Project	TMDL Sites	TMDL Files
Alabama	4[1]	9	12
Iowa	5	11	27
Illinois	10	47	66
Kentucky	2	2	2
Minnesota	2	2	2
Mississippi	0[1]	3	4
Missouri	3	3	4
Montana	4	5	10
Nebraska	2	2	2
Ohio	1	13	19
Oklahoma	10	60	108
Tennessee	11	21	30
Virginia	0[2]	1	1
Wisconsin	1	1	2
Total	55	181	289

1. TMDL sites for Pickwick Hydro were found in both Alabama and Mississippi.
2. The TMDL site was located in Virginia and the South Holtson Hydro was located in Tennessee.

Oklahoma's 10 candidate projects, Kaw, Keystone, Pensacola, Robert S. Kerr, Fort Gibson, Webber Falls Lock & Dam, Tenkiller, Eufaula, Denison, and Broken Bow, are located primarily in the eastern third of the state. In this study 108 TMDL's were identified at 60 TMDL sites. They ranged from a low of 2 TMDL sites associated with the Robert S. Kerr Hydro and Webber Falls L&D, respectively, to 17 TMDL sites at Pensacola Hydro. The other 12 MRB states had between 1 and 4 candidate projects and the number of TMDL's varied from 1 to 47 TMDL sites per state.

The state with the second highest number of TMDL sites was Illinois. Illinois had 47 TMDL's. Thirty-eight TMDL's were found on the Mississippi River and "nutrients" were the major concern. Two of the 38 sites also listed "flow alteration" as a concern. For the purpose of this initial evaluation, all TMDL sites on the Mississippi River were combined into one project. The project was titled Mississippi Hydro and included 3 dams – Mississippi River L&D 19, Arsenal Power Dam, and Moline Power Dam.

A list of USACE hydro projects experiencing dissolved oxygen (DO) problems in the Mississippi River Basin was also compiled (Table 4). The list supported and expanded the previously derived TMDL list in Table 3. Of the 25 USACE projects, 13 were included in the 303(d) database that was evaluated for this study. When the 12 other USACE projects are added to the 55 projects previously identified, there are approximately 67 hydropower projects experiencing DO and related water quality problems in the Mississippi River drainage basin. This number may be higher since water quality data is not collected or if collected, was not readily available, for consideration in this study. (Note: The list of projects in Table 4 was based on information gathered from the USACE's ongoing efforts to improve water quality at their projects. This effort is heavily dependent on each state's interest in hydropower projects and the availability of federal funds. To date, efforts to improve water quality have primarily focused on facility and operational improvements at the dam and have not considered watershed-related concerns.)

Table 4. U.S. Army Corps of Engineers hydropower projects experiencing problems with low dissolved oxygen. (S. Wilhelms, personal communication.)

Reservoir	State	Basin	Dam	TMDL
Eufaula Lake	Oklahoma	Arkansas/White/Red	Eufaula Dam	Yes
Lake Texoma	Oklahoma	Arkansas/White/Red	Denison Dam	Yes
Beaver Reservoir	Arkansas	Arkansas/White/Red	Beaver Dam	No
Bull Shoals Lake	Arkansas	Arkansas/White/Red	Bull Shoals Dam	No
Norfolk Lake	Arkansas	Arkansas/White/Red	Norfolk Dam	No
Greers Ferry Lake	Arkansas	Arkansas/White/Red	Greers Ferry Dam	No
Lake Quachita	Arkansas	Lower Mississippi/Quachita	Blakely Mountain Dam	No
DeGray Reservoir	Arkansas	Lower Mississippi/Caddo	DeGray Dam	No
Lake Greeson	Arkansas	Lower Mississippi/L. Missouri R.	Narrows Dam	No
Table Rock Lake	Missouri	Arkansas/White/Red	Table Rock Dam	Yes
Mark Twain Lake	Missouri	Lower Mississippi/Salt	Clarence Cannon Dam	Yes
Salt River	Missouri	Lower Mississippi/Salt	Clarence Cannon Re-Regulating Dam	No
Harry S. Truman Reservoir	Missouri	Missouri/Osage	Harry S. Truman Dam	Yes
Stockton Lake	Missouri	Missouri/Osage	Stockton Dam	No
Lake Sakakawea	Dakota	Missouri	Garrison Dam	No
Fort Peck Lake	Montana	Missouri	Fort Peck Dam	Yes
Laurel River Lake	Kentucky	Ohio/Cumberland	Laurel Dam	No
Lake Barkley	Kentucky	Ohio/Cumberland	Barkley Dam	Yes
Lake Cumberland	Kentucky	Ohio/Cumberland	Wolf Creek Dam	No
Dale Hollow Lake	Tennessee	Ohio/Cumberland	Dale Hollow Dam	Yes
Cordell Hull Reservoir	Tennessee	Ohio/Cumberland	Cordell Hull Dam	No
Center Hill Lake	Tennessee	Ohio/Cumberland	Center Hill Dam	Yes
Old Hickory Lake	Tennessee	Ohio/Cumberland	Old Hickory Dam	Yes
J. Percy Priest Lake	Tennessee	Ohio/Cumberland	J. Percy Priest Dam	Yes
Cheatham Lake	Tennessee	Ohio/Cumberland	Cheatham Dam	No

The number of hydropower projects by state and the number of projects experiencing low dissolved oxygen (DO) and related problems in the **combined EPA/USACE data set** (emphasis added) is summarized in Table 5. There are a total of 359 hydropower projects in the Mississippi River Basin (MRB). Approximately 67 projects or 20 percent of the projects in the MRB have water quality problems and may be candidates for trading. Of the 31 MRB states, 24 states had hydropower projects either on the Mississippi River or tributaries draining into the Mississippi River. Eleven of these states, i.e., Colorado, Georgia, Indiana, Kansas, North Carolina, Pennsylvania, South Dakota, West Virginia, Virginia, Mississippi, and Wyoming, did not have candidate-trading projects.

Table 5. Total number of hydropower projects in the Mississippi River Basin, the number of candidate trading projects, and the percent of state projects that are candidate trading projects.

State	Hydro Projects (#)	Candidate Projects (#)	Percent (%)
Alabama	3	3	100
Arkansas	20	7	35
Colorado	20	0	0
Georgia	2	0	0
Illinois	13	10	77
Indiana	3	0	0
Iowa	8	5	63
Kansas	2	0	0
Kentucky	9	4	44
Minnesota	24	2	8
Missouri	8	5	63
Montana	15	4	27
Nebraska	43	2	5
North Carolina	18	0	0
North Dakota	1	1	100
Ohio	2	1	50
Oklahoma	12	10	83
Pennsylvania	3	0	0
South Dakota	4	0	0
Tennessee	26	12	46
Virginia	7	0	0
West Virginia	3	0	0
Wisconsin	103	1	1
Wyoming	10	0	0
Totals	359	67	19

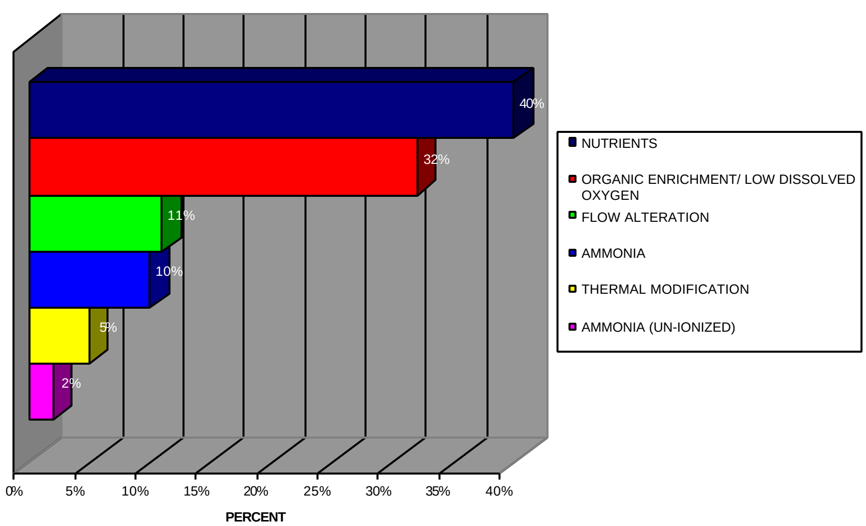
Table 6 provides a breakdown of the 359 MRB hydropower projects and the 67 EPA/USACE projects by storage capacity. The “High Volume” hydropower projects have a greater incidence (50 percent) of water quality concerns than the “Moderate” or “Low” volume projects. This could be attributed to a combination of factors including hydraulic retention time, potential for stratification, development within the watershed, the retention of pollutants by the reservoir, and the age of the impoundment. Another important factor may be the availability of water quality data. That is, the public tends to visit large reservoirs having recreation facilities more frequently than smaller projects. As a result, they are more likely to have water quality data because of the public use.

Table 6. Summary of the number of hydropower projects by volume size and the number of projects with water quality concerns that may be candidate trading projects.

Reservoirs	Projects (#)	Potential for Trading	Percent of Projects
High Volume	94	47	50
Moderate Volume	130	9	7
Low Volume	135	11	8
Totals	359	67	19

When the 289 TMDL "CAUSES" were analyzed, the most often reported concern was nutrients. Nutrients were found in the screened TMDL files 40 percent the time (Figure 2). This was closely followed by "organic enrichment/low dissolved oxygen" which was reported 32 percent of the time. The 4 other causes, i.e.; flow alteration (ll%), ammonia (10%), thermal modification (5%), and un-ionized ammonia (2%); made up a combined 28 percent of the reported causes.

Figure 2. Water quality concerns at hydropower projects in the Mississippi River Basin, June 2000.

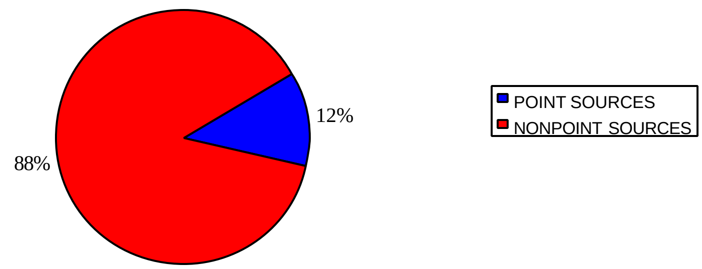


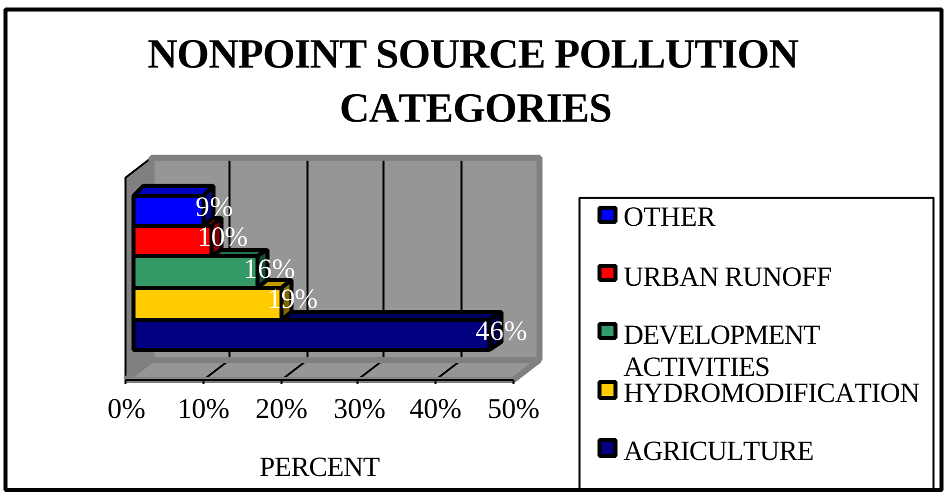
To determine the relative frequency of each source in the hydropower/TMDL database, the source records for the 181 screened TMDL sites were analyzed. The TMDL sources were grouped into 7 general categories, i.e., municipal point sources, industrial point sources, agricultural nonpoint sources, hydromodification, development related nonpoint sources, urban runoff/storm sewers, and other.

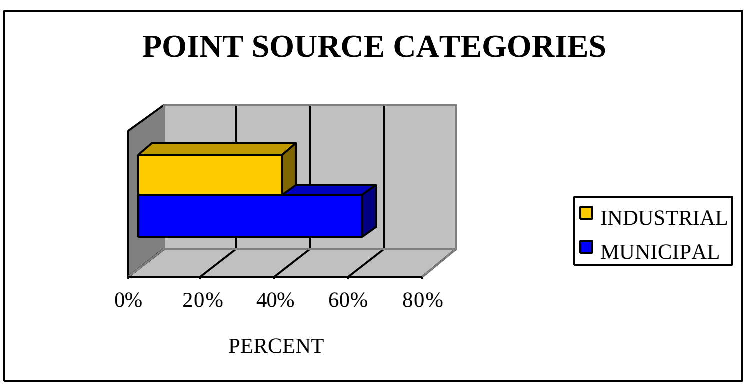
Approximately 88 percent of the listed TMDL "SOURCES" were nonpoint (Figure 3). The nonpoint category most often listed was agriculture. When nonpoint sources are considered independently of point sources, agriculture was reported 46 percent of the time. Hydromodification was the next highest nonpoint source at 19 percent. Land development related activities were the third most often reported TMDL source at 16 percent. Urban runoff and "other" nonpoint sources were 10 and 9 percent, respectively.

Point sources were listed only 12 percent of the time (Figure 3). When point sources were considered independent of the nonpoint sources, the relative frequency of the municipal and industrial point source categories was determined. That is, municipal point sources were observed 61 percent of the time when only point sources were considered. The industrial point sources were observed 39 percent of the time.

Figure 3. General categories of pollution contributing to TMDL concerns at hydropower projects in the Mississippi River Basin, June 2000.







Watershed Impacts on Hydropower Reservoirs With TMDLs

Water quality characteristics of the inflows to the reservoirs with TMDL sites in the reservoir or immediately upstream from the reservoirs were assessed to

1) Compare these conditions with USGS and Tennessee Valley Authority/Tennessee Technological University (TVA/TTU) data on inflows to hydropower projects without TMDL's,
2) To assess the adequacy of available water quality data in the inflows to hydropower reservoirs for diagnostic evaluations and developing management strategies, and
3) To suggest possible water quality management alternatives.

Data from STORET and a special three-year study of 13 inflows to 8 TVA hydropower reservoirs were used to conduct the assessment. The analysis focused on phosphorus, total organic carbon (TOC), and five-day biochemical oxygen demand (BOD_5) since these parameters are most often associated with dissolved oxygen, nutrient concerns, and organic enrichment problems in reservoirs. Data collected after 1984 were selected to indicate the general condition of water quality after the implementation of EPA and the states' construction grants program and the achievement of point source controls by industrial operations.

STORET data were retrieved for all States in the Mississippi River Basin for the following parameters:

TKN, TKJN, KJN, "nitrogen, ammonia + organic, total"
NH_4, TNH_4,
TP, TPO_4
TOC, TCARBON
Suspended Organic Carbon
Dissolved Organic Carbon
BOD_5 and C-BOD_5
BOD_{20} and C-BOD_{20}
BOD_{28} and C-BOD_{28}
BOD_{30} and C-BOD_{30}
Flow

Seventy-seven (77) inflow sites were found to be associated with the TMDL designated stream reaches, and were searched for data. Data on total phosphorus (TP) were found for 49 of the inflows or approximately 64 percent of the inflow sites. These data are presented in a graph (Figure 4) that shows the percentile ranking for all the values of TP. (Note: Each data point on the graph represents one of the TMDL sites where data were found in STORET.) TOC data were found for 33 of the inflows or 43 percent of the inflow sites, and the percentile-ranking graph is presented in Figure 5. Data on BOD_5 were found for 19 of the inflows, which was 25 percent of all the TMDL inflows. The BOD data was not considered for further consideration in this study.

Figure 4. Percentile rankings for total phosphorus (TP) at TMDL sites in the Mississippi River Basin and for non-TMDL inflow sites for hydropower reservoirs.

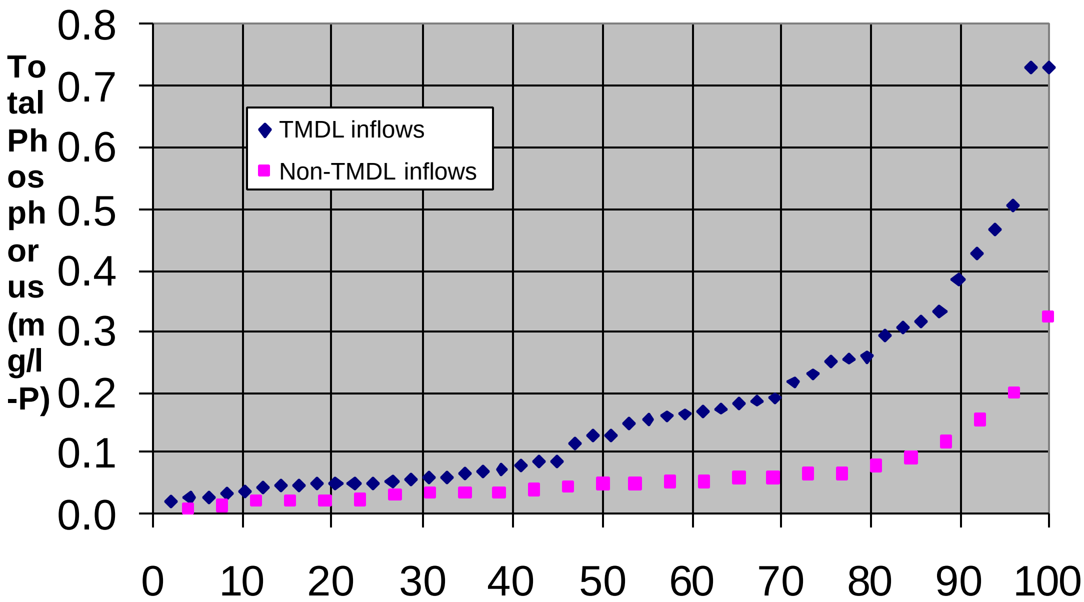
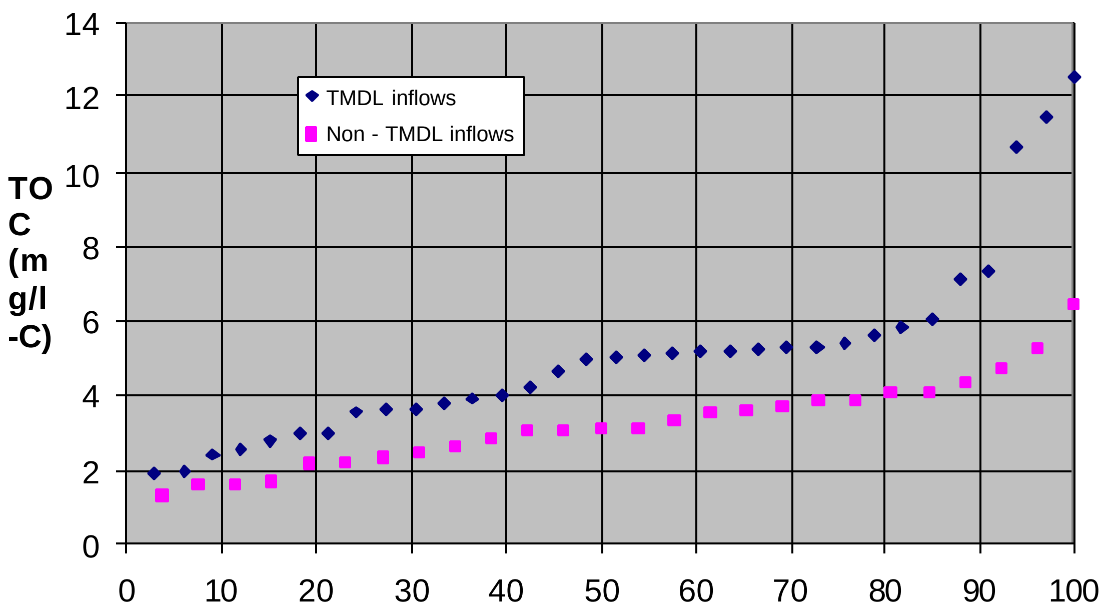


Figure 5. Percentile rankings for total organic carbon (TOC) at TMDL and Non-TMDL inflow sites for hydropower reservoirs.



The median values for TP, TOC, and BOD_5 for the inflows to the TMDL sites at hydropower reservoirs are greater than the same median values where USGS and TVA/TTU data are available for inflows to hydropower projects without TMDL sites. The comparison is shown in the following table (Table 7).

Table 7. Comparison between median values of TP, TOC, and BOD_5 for inflows to hydropower reservoirs with TMDL sites and inflows to hydropower reservoirs without TMDL sites.

	Inflows to TMDL sites at hydropower reservoirs (data from all agencies), mg/l	Inflows to hydropower reservoirs without TMDL sites (USGS and TVA/TTU data), mg/l
Total Phosphorus	0.128	0.048
Total Organic Carbon	5.02	3.09
BOD_5	1.5	1.3

The median TP concentrations in the inflows to hydropower projects with TMDL sites are 2.7 times greater than the 0.048 mg/l observed for the inflows to hydropower reservoirs without TMDL sites using the USGS and TVA/TTU data. The median TOC concentrations in the inflows to hydropower projects with TMDL sites are 1.6 times greater than the 3.09 mg/l observed for the inflows to hydropower reservoirs without TMDL sites using the USGS and TVA/TTU data. Our analysis also indicates that about 80 percent of the inflows to TMDL sites have TP, TOC and BOD_5 concentrations that exceed the median values for TP, TOC and BOD_5 in the inflows to hydropower projects without TMDL sites where USGS and TVA/TTU data have been collected.

The highest values for TP and TOC were generally found in the Arkansas-White-Red and Upper Mississippi Sub-Basins, as indicated in Table 8. For TP, 8 of the top 13 values for mean TP were from the Arkansas-White-Red Sub-Basin. The mean TP values for the Upper Mississippi Sub-Basin exceeded 63 percent of the mean values for the other TMDL sites. For TOC, the Upper Mississippi had the 5 highest values of the 33 sites with data and the Arkansas-White-Red had the next 4 highest values. The Ohio Sub-Basin had the lowest percentage of sites for TOC occurrences, but this was attributed to the lack of sufficient TOC data for this sub-basin, i.e., there were TP data for 7 sites in the Ohio Sub-Basin but there were only 2 sites that had TOC data.

Table 8. Percentage of TMDL sites for each Mississippi River Sub-Basin that exceeded the top 50% and 80% of all mean values for TP and TOC, respectively.

	Total Phosphorus		**Total Organic Carbon**	
	Top 50 % of mean values (> 0.13mg/l)	**Top 80 % of mean values (>0.048mg/l)**	**Top 50 % of mean values (>5.0 mg/l)**	**Top 80 % of mean values (>3.1 mg/l)**
Ark-White-Red	44	36	47	38
Upper Mississippi	20	13	29	19
Ohio	20	18	0	4
Missouri	12	10	6	12
Tennessee	4	23	18	27
Lower Mississippi	0	0	0	0
Total Percent	100	100	100	100
Total # of sites exceeding the specified levels	25	39	17	26

There were insufficient BOD_5 data to present regional distributions. Data were available for only 19 sites, and half of those were in the Tennessee Sub-Basin. There were no BOD_5 data for the Upper Mississippi Sub-Basin. BOD data are useful for estimating the amount of TOC that is biodegradable within 30-60 days, but BOD data were available for only 20 percent of the top 60 % of the TOC values.

It should be noted that elevated inflow concentrations of TP and TOC to reservoirs without TMDL sites were notably higher in the state of Arkansas compared to elevated TP and TOC concentrations in other states. The inflows in Arkansas accounted for almost 40 percent (5 sites out of 13) of all the inflows with concentrations of TP and TOC exceeding the 50-percentile ranking. The state of Arkansas listed relatively few TMDL sites in hydropower reservoirs. This was unexpected considering the high number of inflows in Arkansas that have TP and TOC concentration that appear comparable to TP and TOC concentrations in the top 80 percent of the inflows to reservoir with TMDL sites.

This analysis indicates that hydropower reservoirs with designated TMDL sites have greater loads of pollutants from their watersheds than those reservoirs without TMDL sites. It is apparent that water quality improvements can be achieved through implementation of controls for contaminants in the watersheds upstream of hydropower reservoirs with TMDL sites. Reservoir water quality improvements were reported for at least three reservoirs in the Tennessee Valley (Ruane and Hauser, 1991). An improvement of 1 mg/l in the DO in releases from Ft. Loudon reservoir followed increased treatment of wastewater discharges from Knoxville, TN. An increase of 2 mg/l DO in the releases from Fontana Hydro was also observed following the closure of a paper mill in the upstream watershed. Finally, an increase of about 2 mg/l DO in the releases from Ft. Patrick Henry Dam was observed when wastewater treatment levels were increased at upstream chemical plants.

Controllable water quality contaminants that affect DO and algae in lakes include TOC and BOD (i.e., organic matter), ammonia, and nutrients. Models can determine fairly reliably the effect of organic matter and ammonia loads on DO consumption, but determining the effects of nutrients on algal growth and DO concentrations is more difficult and involves more uncertainty. For example, phosphorus generally settles into the sediments of reservoirs and cycles back into the water column under anoxic conditions. It can become available for algal growth following mixing events or sufficient upward diffusion in the water column. Cooke, et al. (1986) reported that internal loading of phosphorus was nearly impossible to predict using generalized models that apply to all lakes. The rate of decrease in internal phosphorus cycling after watershed improvements is also difficult to predict, but can take anywhere from 3 to over 20 years depending on many factors, including the flushing rate through the reservoir and the time it takes phosphorus to "wash out" of the watershed system. Of the 28 lakes reported by Cooke et al. (1986), only 12 improved in trophic status following the diversion of wastewater discharges, thus indicating the importance of site-specific analyses instead of assuming reservoirs will improve with the reduction of nutrients in the watershed.

For most of the TMDL sites, the inflow data that were analyzed were not sufficient to do diagnostic evaluations for different water quality management alternatives, especially in-lake alternatives. That is, there were not enough watershed-loading data to model the sites to determine whether aeration systems or other watershed management alternatives should be pursued to improve water quality and assimilative capacity. Watershed inflow data for only about 20-25 sites (about 30 % of the inflow sites) were considered sufficient to make these initial evaluations. Also, the data needed to predict internal nutrient cycling were not available for most lakes and the development of water quality management strategies.

Prioritization of Candidate Trading Projects

With the completion of the TMDL queries and the analysis of available water quality inflow data, the 55 candidate projects identified in Table 3 were prioritized. Four categories: High, Medium, Low, and Unknown; were adopted based on discussions with state TMDL coordinators and the priority given by the state for each TMDL. Using this prioritization scheme 10 high priority, 4 medium priority, 25 low priority, and 16 unknown priority projects were identified (Appendix 6).

When there was more than one project in a category the projects were ranked based on the following criteria:

(1) public water supply concerns,
(2) threatened and endangered species considerations,
(3) potential for active public participation,
(4) potential interest in trading,
(5) state project designation,
(6) availability of data, and
(7) precedent.

Using these criteria the projects in the "High" and "Medium" categories were ranked. The 14 projects were divided among 5 states as indicated in Table 9.

Table 9: Ranking of priority projects identified by the states in the hydropower survey of the Mississippi River Basin – July 2000.

Project (State)	Project Priority High	Project Priority Medium
Pensacola (Oklahoma)	X	
J. Percy Priest (Tennessee)	X	
Cheatham (Tennessee)	X	
Old Hickory (Tennessee)	X	
Tenkiller (Oklahoma)	X	
Broken Bow (Oklahoma)	X	
O'Shaughnessy (Ohio)	X	
Webber Falls L&D (Oklahoma)	X	
Barkley (Kentucky)	X	
Dix (Kentucky)	X	
Keystone (Oklahoma)		X
Table Rock (Missouri)		X
Eaufaula (Oklahoma)		X
Harry S. Truman (Missouri)		X

The state of Oklahoma has 6 projects, Tennessee (3 projects), Kentucky (2 projects), Missouri (2 projects), and Ohio (1 project). A description of each of these candidate trading projects is summarized as follows beginning with the 10 High Priority projects followed by the 4 Medium Priority projects.

Candidate Trading Projects – High Priority

Pensacola Hydro – Neosho (Grand) River (Oklahoma)

One of the major tributaries of the Arkansas River in eastern Oklahoma is the Neosho or Grand River. In the northeastern corner of the state the Pensacola Dam impounds the Neosho River to create the Grand Lake O' the Cherokees (Figures 6 and 7). The river and its impoundment are also called the Grand Lake Project. There are 17 TMDL sites and 37 TMDL files associated with Pensacola Hydro. The 17 sites have between 1 and 3 TMDL files or water quality concerns per site. Nutrients and organic enrichment/DO are a concern at 16 sites, and ammonia is a concern at 5 sites. The state of Oklahoma has made the Grand Lake Project a high priority project because of water quality in the lake and its potential impact on habitat for endangered species (Ozark cavefish, Neosho madtom, and Winged mapleleaf madtom). The water quality concerns are all non-point in origin and include prairie and range lands, non-irrigated crop production, feedlots, activities related to animal holding and management, construction activities, urban runoff, on-site wastewater systems, land disposal, recreational activities, unknown sources, in-placement contaminants, and resource exploration-development-extraction. The Oklahoma DEQ has designated the Grand Lake Project a priority 1. (Note: The Grand River Dam Authority owns Pensacola Dam. The project is subject to re-licensing by FERC, project # 1494, license expiration: March 31, 2022.)

Old Hickory, J. Percy Priest, and Cheatham Hydros - Cumberland and Stones River (Tennessee)

Old Hickory and Cheatham Hydros are USACE projects on the Cumberland River (Figures 8,9,10, and 11). Old Hickory is upstream from Nashville about 10 miles to the northeast, and Cheatham is downstream about 25 miles west of Nashville. The Cumberland River passes through Nashville. The Stones River enters Cheatham Reservoir a few miles downstream from Old Hickory Dam and upstream from Nashville. The Stones River is impounded by J. Percy Priest Dam, which is located about six miles upstream from the confluence of the Stones River with the Cumberland River (Figures 12 and 13).

There are three TMDL sites in Cheatham Reservoir and the cause for each one is organic enrichment/low DO. The sources include the Nashville collection system failure/bypassing, municipal point source, urban runoff/storm sewers, land development, and hydromodification. The sources are also impacted by turbine releases with poor quality from Old Hickory Reservoir. All three TMDL sites are designated as high priority.

There are three TMDL sites on the Stones River, two downstream from J. Percy Priest Dam and one upstream on the West Fork of the Stones River. The causes downstream from the dam are organic enrichment/low DO and flow alterations, and the source is the dam. The cause also includes manganese and sulfides below Percy Priest (sulfides cause an odor problem below the dam.) The TMDL site on the West Fork of the Stones is caused by organic enrichment/low DO, and the source is land development and

Figure 6. Hydrologic unit map for the state of Oklahoma.

Figure 7. Map of Lake O' The Cherokees Hydrologic Unit which includes Pensacola Dam and TMDL stream segments draining into the upstream reservoir.

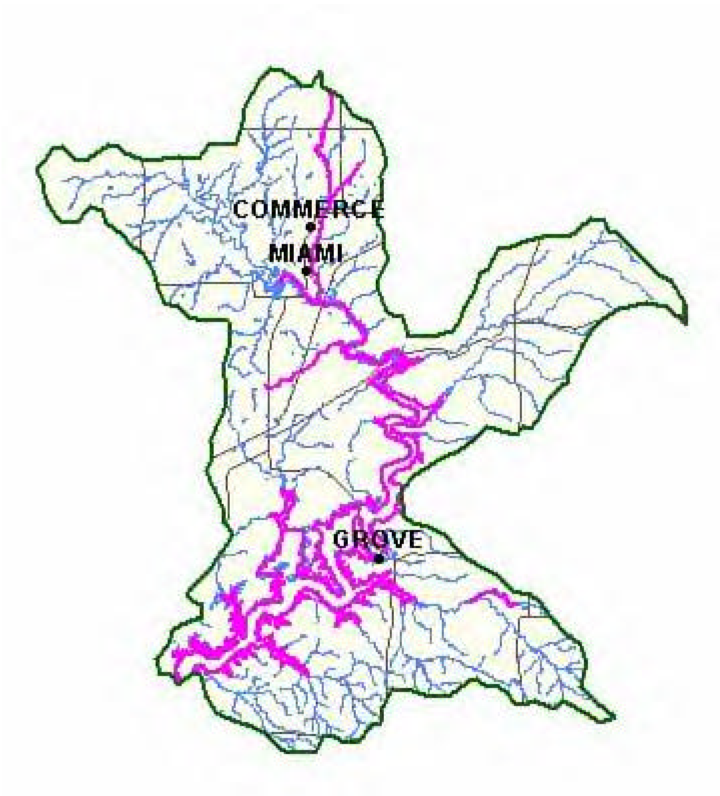


Figure 8. Hydrologic unit map for the state of Tennessee.

Figure 9. Map of the Lower Cumberland – Old Hickory Lake Hydrologic Unit and the TMDL stream segments along the Lower Cumberland River.

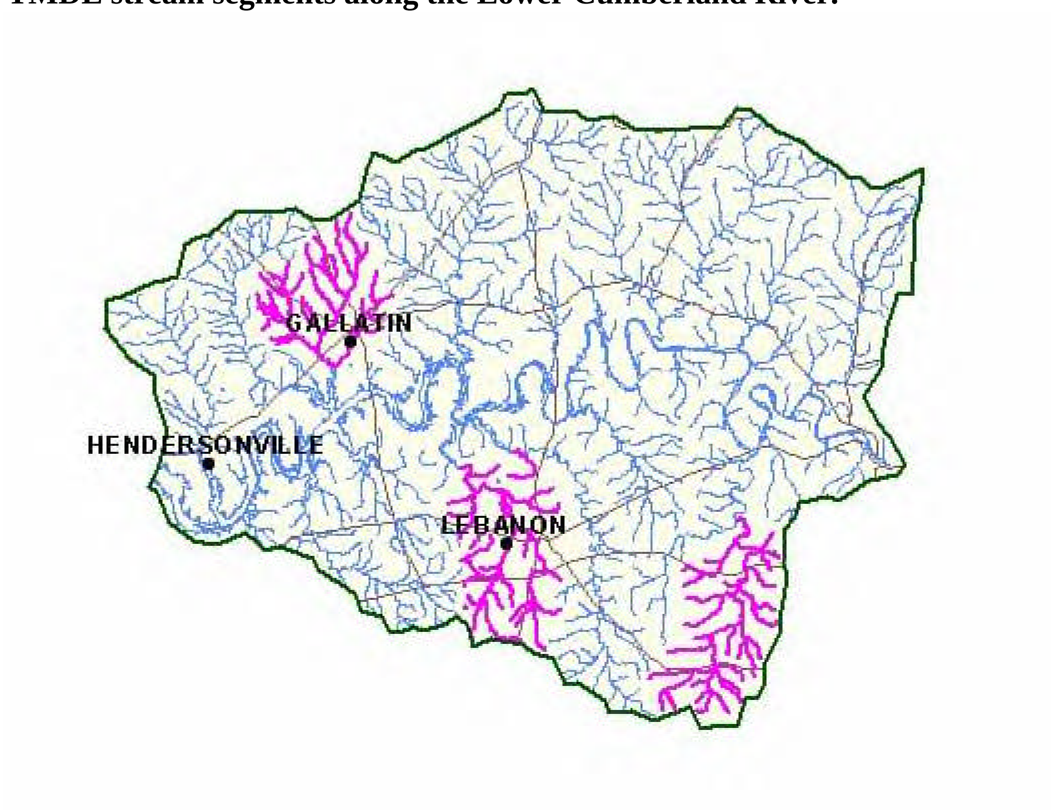


Figure 10. Hydrologic unit map for the state of Tennessee.

Figure 11. Map of the Lower Cumberland – Sycamore Hydrologic Unit containing the TMDL stream reaches draining into Cheatham Lake.

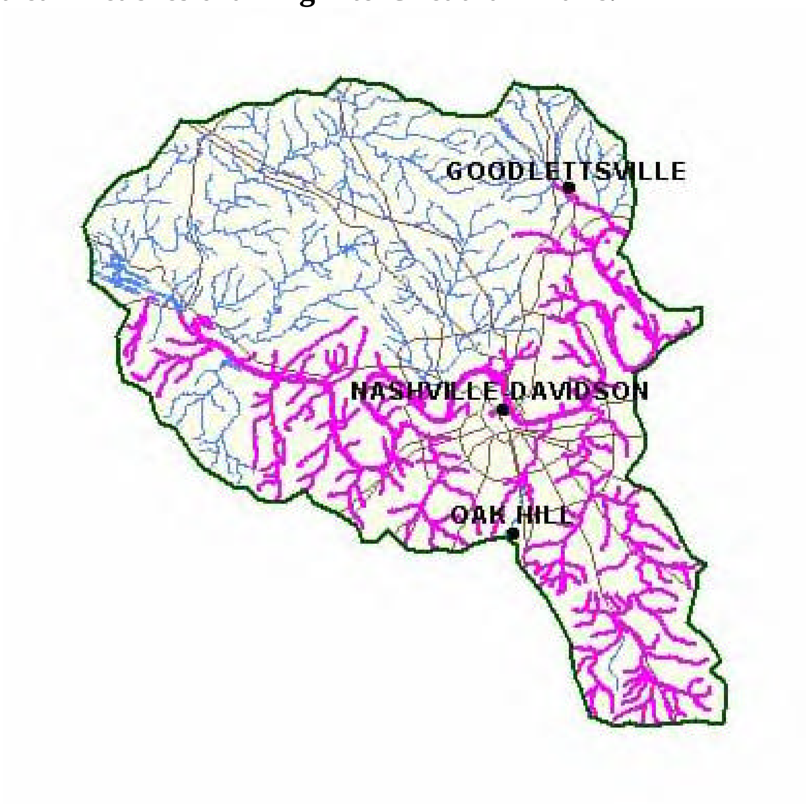


Figure 12. Hydrologic unit map for the state of Tennessee.

Figure 13. Map for the Stones Hydrologic Unit which contains J. Percy Priest Dam and TMDLs attributed to the dam and TMDL stream segments associated with the upstream reservoir.

a municipal point source. Land development is causing impacts around Old Fort Parkway, and the municipal point source is from Murfreesboro STP impacts. The TMDL site on the West Fork of the Stones River is listed as a high priority. The TMDL site in the West Fork of the Stones River may affect water quality in J. Percy Priest Reservoir and may be an opportunity for trading. (Note – The state of Tennessee has identified these projects as a high priority.)

Tenkiller Hydro – Illinois River (Oklahoma)

Tenkiller Hydro is a USACE project located on the Illinois River in eastern Oklahoma and the river is a major tributary of the Arkansas River (Figures 14 and 15). There are 8 TMDL sites and 18 TMDL files associated with Tenkiller Hydro. Each site has between 1 and 4 files or water quality concerns per site. Organic enrichment/DO is a concern at every site. Nutrients are a concern at 6 sites and flow alteration is a concern at 4 sites. The water quality problems are associated with runoff from prairie and range lands, animal feedlots, flow regulation/modification, non-irrigated crop production, land development, animal holding and management, highways/bridges. The Oklahoma DEQ has identified these TMDL sites a priority 1 and they are part of the designated Illinois River Project.

Broken Bow Hydro – Mountain Fork (Oklahoma)

Broken Bow Hydro is a USACE project located in southeastern Oklahoma on Mountain Fork, a tributary of the Red River (Figures 16 and 17). There are 3 TMDL sites and 4 TMDL files associated with Broken Bow Hydro. Nutrients and/or organic enrichment/DO are a concern at each site. The water quality problems in Broken Bow Lake are attributed to agricultural operations, in-placement contaminants, and unknown sources. The water quality problems in the Little River and Mountain Fork River are attributed to animal holding/management, atmospheric deposition, and unknown sources. The state has identified the tributary sites as priority 1 sites and Broken Bow Lake as priority 2.

O’Shaughnessy Hydro – Scioto River (Ohio)

The Scioto River has a number of TMDL sites from its headwaters in north central Ohio to its confluence with the Ohio River near Portsmouth, Ohio. Three TMDL sites for nutrients (2) and organic enrichment/DO are associated with O’Shaughnessy Hydro and J. Griggs Reservoir just north of Columbus, Ohio Figures (18 and 19). As the Scioto River winds through Columbus it receives flows from the Olentangy River and Big Walnut Creek. Each stream has an upstream, non-hydropower impoundment. Delaware Lake is on the Olentangy River and Hoover Reservoir is on Big Walnut Creek. The stream segments downstream of these impoundments have flow alteration, ammonia, organic enrichment/DO, and thermal modification concerns. The TMDL’s are attributed to industrial and municipal point sources, non-irrigated crop production, irrigated crop production, range and pastureland, feedlots, land development, hydromodification, upstream impoundment, flow regulation/modification, and urbanization.

Hargus Creek joins the Scioto River about 20 miles downstream of Columbus, Ohio. A non-hydropower dam, Hargus Lake, is located on Hargus Creek. The lake has nutrients, ammonia, organic enrichment/DO, and flow alteration TMDL’s. The creek has

Figure 14. Hydrologic unit map for the state of Oklahoma.

Figure 15. Map of the Illinois Hydrologic Unit which includes Tenkiller Dam and TMDL stream segments draining into Tenkiller Ferry Lake.

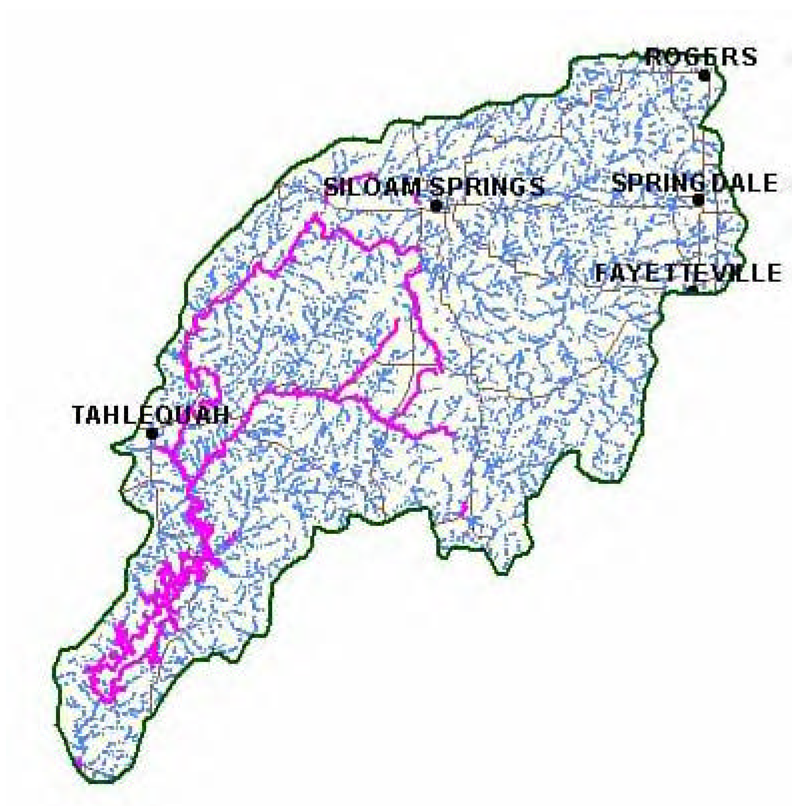


Figure 16. Hydrologic unit map for the state of Oklahoma.

Figure 17. Map of the Mountain Fork Hydrologic Unit which contains Broken Bow Dam and TMDL stream segments draining into Broken Bow Lake.

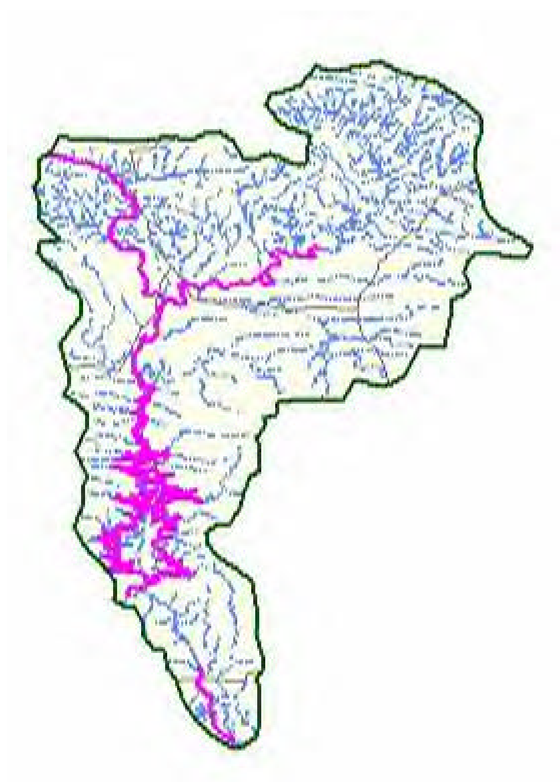


Figure 18. Hydrologic unit map for the state of Ohio.

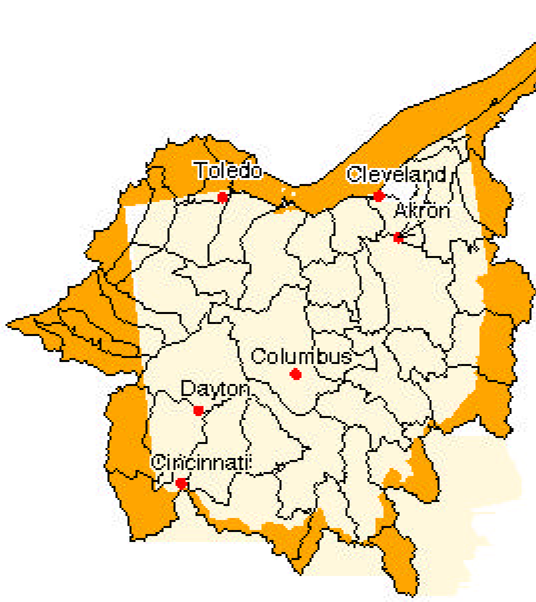
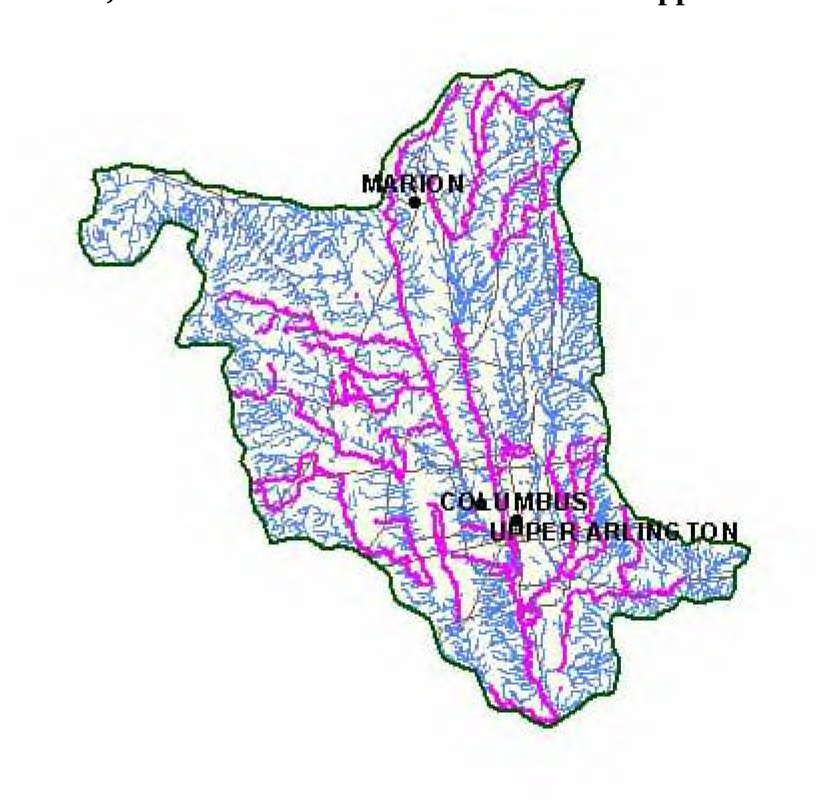


Figure 19. Map of the Upper Scioto Hydrologic Unit which includes O'Shaughnessy Reservoir and dam, and the TMDL stream reaches in the Upper Scioto River Basin.



organic enrichment/DO concerns. The TMDL concerns are attributed to municipal point sources, urban runoff/sewer overflow, combined sewer overflow, and on-site waste systems.

Deer Creek joins the Scioto River approximately 20 miles downstream of its confluence with Hargus Creek. Deer Creek has two non-hydropower impoundments, Deer Creek Lake and Madison Lake. Both lakes have nutrients and organic enrichment/DO TMDL's, and Deer Creek Lake has ammonia concerns. The TMDL concerns are attributed to agriculture, pasture and rangeland, non-irrigated crop production.

Paint Creek joins the Scioto River approximately 10 miles downstream of its confluence with Deer Creek and just south of Chillicothe, Ohio. Paint Creek has three non-hydropower impoundments; Rocky Fork Lake, Hillsboro Reservoir, and Paint Creek Lake. TMDL's for these lakes include nutrients and organic enrichment/DO. The TMDL concerns are attributed to industrial and municipal point sources, agriculture, and non-irrigated crop production. (Note: The Ohio Environmental Protection Agency has not assigned a priority to these TMDL sites. It should also be pointed out that this is the only project that considered the possible integration of hydropower and water supply reservoirs into a "Watershed Trading Option". And lastly, O'Shaughnessy Hydro is a low-head, moderate volume project typical of the myriad of projects found in the Midwest and Upper Mississippi Basin.)

Webber Falls L&D – Arkansas River (Oklahoma)

Webber Falls L&D is a USACE project on the Arkansas River between Tulsa and the OK-AR state line (Figures 20 and 21). There are two priority 1 TMDL sites on the Arkansas River near Muskogee, and nutrients and organic enrichment/low DO are concerns at each site. The water quality problems are attributed to pollutants from prairie and range lands, feedlots of all types, and land disposal. There is also a priority 2 TMDL site that has nutrients as a concern. The nutrients are attributed to storm sewers and non-point pollutants from prairie and range lands, feedlots, non-irrigation crop production, surface mining, and dam construction.

Barkley Hydro—Cumberland River (Kentucky)

Barkley Hydro is a USACE project located on the Cumberland River (Figures 22 and 23). There is a TMDL site on the Little River which discharges into Lake Barkley about 20 miles west of Hopkinsville, KY, which is about 50 miles northwest of Nashville, TN. The cause of the TMDL is nutrients, but the actual location of the TMDL needs to be determined to see if it impacts the Little River arm of Lake Barkley. The Little River arm is the largest arm of Lake Barkley other than the Cumberland River arm. The source of the TMDL was not given, but the state of Kentucky has designated it a "first priority."

Dix River Hydro—Dix River (Kentucky)

Dix River Hydro is located on the Dix River and impounds Herrington Lake, which is about 20 miles southwest of Lexington, KY (Figures 24 and 25). There is one TMDL site for Lake Herrington and the concern is organic enrichment/low DO. The Kentucky Division of Environmental Protection is currently completing the TMDL for Herrington Lake.

Figure 20. Hydrologic unit map for the state of Oklahoma.

Figure 21. Map of the Dirty-Greenleaf Hydrologic Unit which contains Webber Falls Lock & Dam and TMDL stream segments draining into Webber Falls Reservoir.

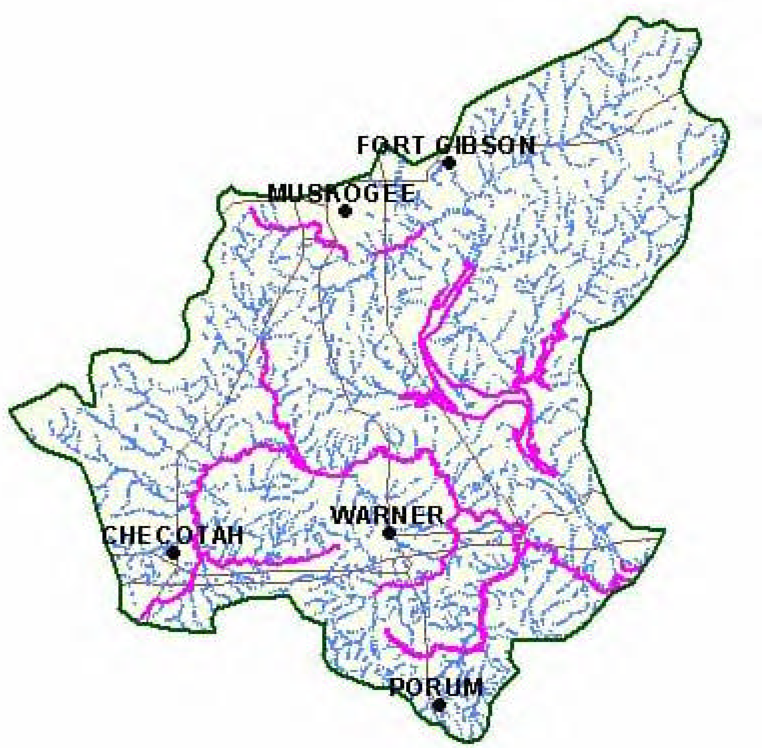


Figure 22. Hydrologic unit map for the state of Kentucky.

Figure 23. Map of the Kentucky Lake Hydrologic Unit and the TMDL stream segments draining into upper Lake Barkley which is created by Barkley Dam in Tennessee.

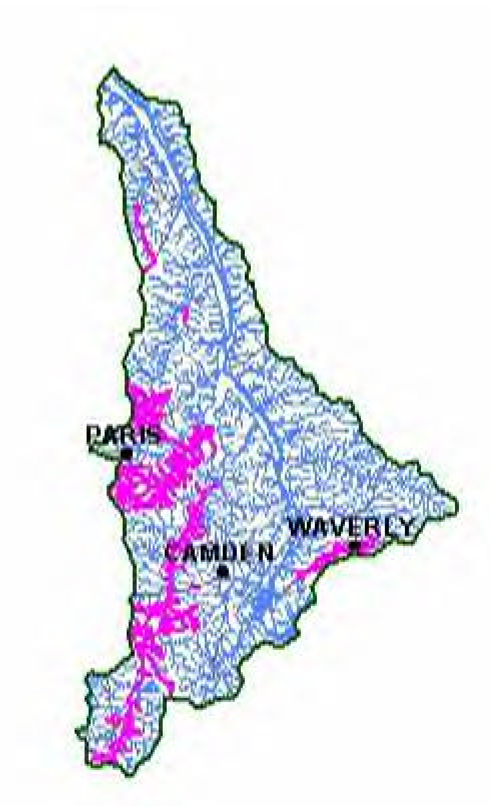
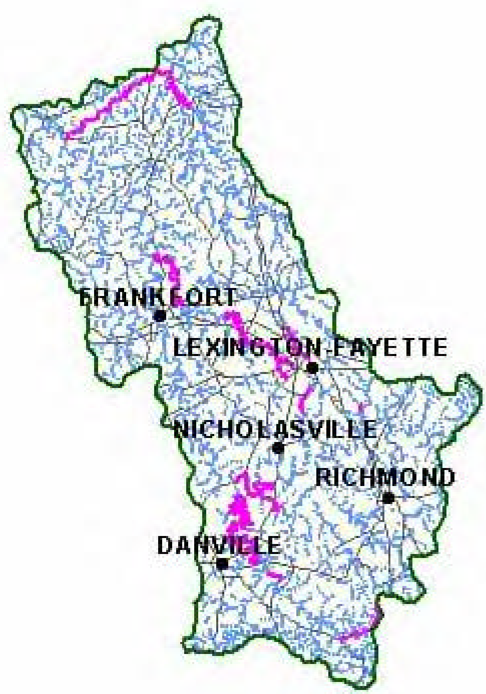


Figure 24. Hydrologic unit map for the state of Kentucky.

Figure 25. Map of the Lower Kentucky Hydrologic Unit and the TMDL stream segments associated with Herrington Lake.



Candidate Trading Priority Projects – Medium Priority

Keystone Hydro – Arkansas River (Oklahoma)

Keystone Hydro is a USACE project located downstream of Kaw Lake on the Arkansas River and west of Tulsa (Figures 26 and 27). The reservoir pool includes the confluence of the Cimarron and Arkansas Rivers. There are 6 TMDL sites and 13 TMDL files associated with Keystone Hydro. The 6 TMDL sites have between 1 and 4 TMDL files or water quality concerns per site. The state of Oklahoma has identified nutrients, organic enrichment/DO, thermal stratification, and flow alteration as water quality concerns. Nutrients are a concern at 5 sites; organic enrichment and thermal modification at 3 sites; and flow alteration is a concern at 2 sites. The water quality concerns are attributed to pollutant runoff from prairie and range lands, crop production, highway maintenance/runoff, in-place contaminants, removal of riparian vegetation, and natural sources. One TMDL site also identified petroleum activities as a concern. The Oklahoma DEQ has designated the reservoir TMDL's as priority 3 sites and the Arkansas River sites as priority 2.

Table Rock Hydro – Lower Missouri (Missouri)

Table Rock Hydro is a USACE project on the White River near Branson, Missouri (Figures 28 and 29). The project is experiencing low dissolved oxygen problems which affects 1,730 acres. The Corps of Engineers has installed turbine venting to increase DO and is working on an aeration option feasibility study. The state of Missouri has identified this project as a medium priority.

Eufaula Hydro – Canadian River (Oklahoma)

Eufaula Hydro is a USACE project located on the Canadian River just upstream of its confluence with the Arkansas River in eastern Oklahoma. It's about 50 miles south of Tulsa and 100 miles east of Oklahoma City (Figures 30,31, and 32). There are 5 TMDL sites and 6 TMDL files associated with Eufaula Hydro. Organic enrichment/DO is a concern at 3 sites. Nutrients and ammonia are a concern in the Mill Creek Arm of Eufaula Lake, and flow alteration is a concern at one site in the lake. The water quality problems are attributed to runoff from pasture land, range lands, and non-irrigated crop production at the sites experiencing organic enrichment, nutrients, and ammonia concerns. The flow alteration is also a concern in Eufaula Lake. The Oklahoma DEQ has designated the TMDL's in Eufaula Lake as priority 4 sites and the 2 TMDL sites experiencing organic enrichment/DO as priority 2 and 3 sites, respectively.

Harry S. Truman Hydro – Lower Missouri (Missouri)

Harry S. Truman Hydro is a USACE project on the Osage River near Warsaw, Missouri (Figures 33, 34, and 35). The project has one TMDL site that is experiencing problems with low dissolved oxygen and gaseous supersaturation. At certain times of the year this condition causes fish trauma that affects a 50-mile section of the river. The state of Missouri has identified this project as a medium priority.

Figure 26. Hydrologic unit map for the state of Oklahoma.

Figure 27. Map of the Black Bear – Red Rock Hydrologic Unit which includes Keystone Dam and the TMDL stream segments draining into Keystone Lake.

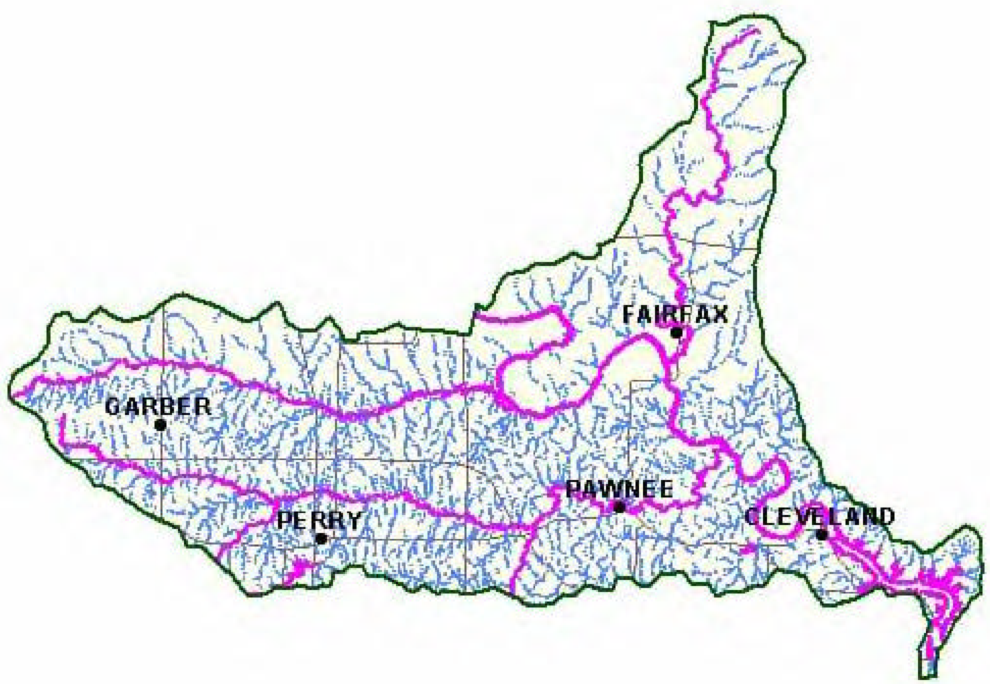


Figure 28. Hydrologic unit map for the state of Missouri.

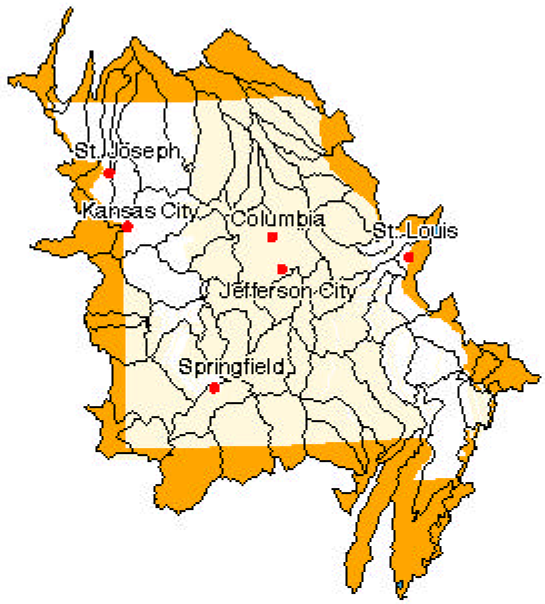


Figure 29. Hydrologic map for Bull Shoals Lake in Missouri and the influence of the upstream Table Rock Dam.

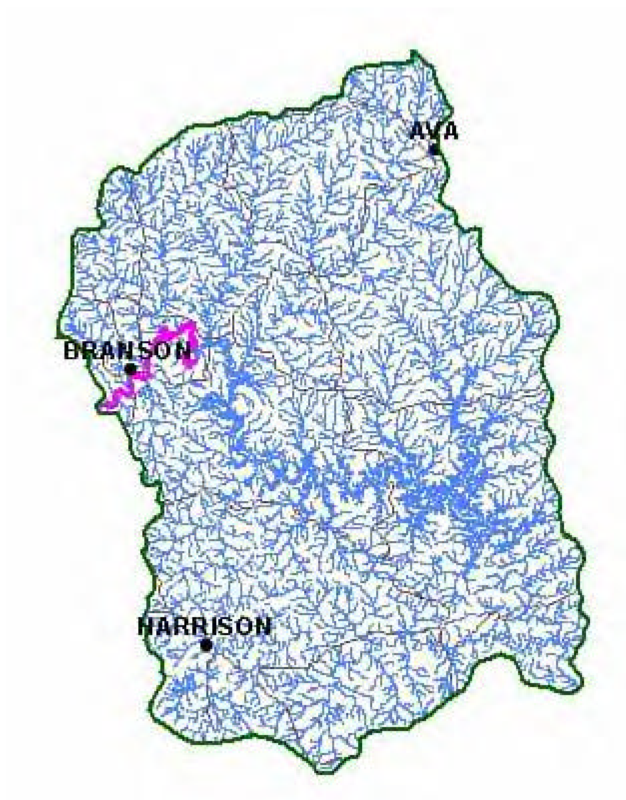


Figure 30. Hydrologic unit map for the state of Oklahoma.

Figure 31. Map of the Lower North Canadian Hydrologic Unit containing the North Canadian River Arm of Eufaula Lake and the associated TMDL stream segments.

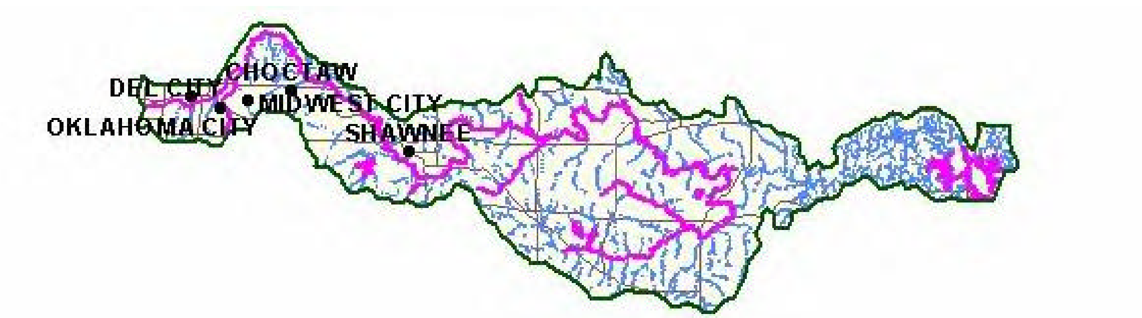


Figure 32. Map of the Lower Canadian River Hydrologic Unit which includes the Canadian River Arm of Eufaula Lake and the associated TMDL stream segments.

Figure 33. Hydrologic unit map of the state of Missouri.

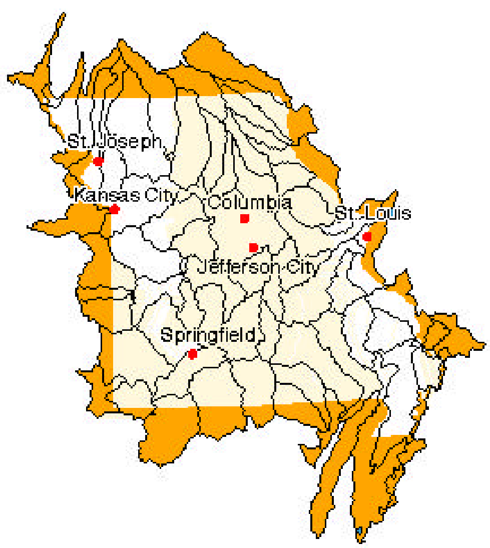


Figure 34. Map of the South Grand Hydrologic Unit with basin TMDL stream segments and TMDL designated Harry S. Truman Reservoir highlighted.

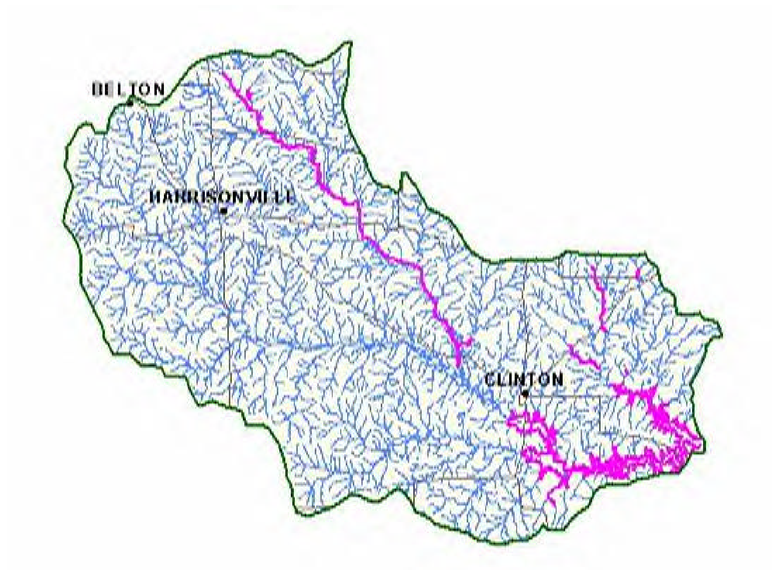


Figure 35. Map of the Lake of the Ozarks Hydrologic Unit with the TMDL designated influence of the upstream Harry S. Truman Dam and other sources highlighted.

Conclusions

The genesis of this water quality study was the Clinton Administration's "Reinventing Environmental Regulations" initiative. The purpose of this study was to identify potential pollutant trading opportunities involving hydropower projects in the Mississippi River Basin (MRB). Using the experience gained from the Tennessee Valley Authority's (TVA) program to improve the quality and timing of releases from its hydropower projects and a point/nonpoint tradeoff study involving TVA's Fort Patrick Henry Dam, the following observations and conclusions were reached.

(1) Two pollutant trading options were considered. The first scenario or "Facility Trading Option" involves a hydropower project and a downstream segment that is listed on the state's 303(d) or TMDL (Total Maximum Daily Load) list. The second scenario or "Watershed Trading Option" also included a TMDL designated site in the upstream reservoir and/or inflow sites to the reservoir.

(2) Using the Facility Trading and Watershed Trading Options, 55 hydropower projects with 289 TMDL's were identified as potential candidates for pollutant trading in the MRB.

(3) Thirty-five of the hydropower projects were "high volume" projects with reservoirs containing more than 103,813 acre-feet of storage. Hydropower projects at the other candidate sites were equally divided between "Moderate Volume" and "Low Volume" projects, i.e., 9 and 11 sites, respectfully.

(4) The states and the number of candidate trading projects, in descending order, are Tennessee (11), Oklahoma (10), Illinois (10), Iowa (5), Alabama (4), Montana (4), Missouri (3), Kentucky (2), Nebraska (2), Minnesota (2), Ohio (1), and Wisconsin (1).

(5) The most often cited water quality concern at the screened TMDL sites was nutrients. They were reported 40 percent of the time. Organic enrichment/low dissolved oxygen was identified 32 percent of the time followed by flow alteration (11 %), ammonia (10%), thermal modification (5%), and ammonia (un-ionized) (2%).

(6) Nonpoint sources of pollution were cited more often than point sources as contributing to impaired water quality. Approximately, 88 percent of the TMDL listed categories were nonpoint. The most frequently listed nonpoint source category was agriculture. Excluding point sources, agriculture was reported 46 percent of the time. Hydro-modification was the next highest nonpoint category at 19 percent, followed by land development (16), urban runoff (10), and "other" nonpoint sources (9).

(7) Water quality data for 77 inflow sites to the candidate trading projects were queried and 49 (64%) of the sites had inflow data for total phosphorus (TP), 33 (43%) had total organic carbon (TOC) data, and 19 (25%) had 5-day biochemical oxygen demand ($BOD_{5)}$ data.

(8) The highest values for TP and TOC were generally found in the Arkansas-White-Red and Upper Mississippi Sub-Basins. The Arkansas-White-Red Sub-Basin had 8 of the highest 13 values for TP. The mean values for TP in the Upper Mississippi Sub-Basin exceeded 63 of the mean values for the other TMDL inflow sites with TP data. For TOC, the Upper Mississippi had

the 5 highest values of the 33 sites with data and the Arkansas-White-Red had the next 4 highest values. This limited analysis suggests a regional pattern of high TP and TOC values that warrants further focus, study, and evaluation.

(9) There were insufficient BOD_5 data to present observations on regional water quality. Since BOD5 is a useful indicator of the biodegradability of TOC, i.e., biodegradable within 30-60 days, more water quality data is needed to provide more definitive recommendations

(10) The concentrations of TP and TOC in the inflows to hydropower reservoirs with TMDL sites are much greater than the concentrations of TP and TOC in the inflows to hydropower reservoirs without TMDL sites. A comparison between these two classes of inflows showed that median levels of TP were 2.7 times greater for reservoirs with TMDL sites and median levels of TOC were 1.6 times greater for reservoirs with TMDL sites. Also, about 80 percent of the inflows to TMDL sites exceeded the median concentrations of both TP and TOC for the inflows to non-TMDL sites.

(11) The State of Arkansas had a surprisingly low number of TMDL sites in reservoirs considering the elevated concentrations of TP and TOC in the inflows to Arkansas reservoirs.

(12) Watershed reductions in TP and TOC should result in water quality improvements at TMDL sites, but the degree and rate of improvement in water quality would be site-specific. In-reservoir solutions (e.g., aeration systems in lakes) will likely be required at some reservoirs to achieve water quality objectives.

(13) Using each state’s prioritization system, the 55 candidate trading projects were divided into 10 “High Priority”, 4 “Medium Priority”, 25 “Low Priority”, and 16 “Unknown Priority” projects. The High and Medium priority projects were ranked using 7 criteria. The highest to lowest project rankings are: Pensacola Hydro (Oklahoma), J. Percy Priest Hydro (Tennessee), Cheatham Hydro (Tennessee), Old Hickory Hydro (Tennessee), Tenkiller Hydro (Oklahoma), Broken Bow Hydro (Oklahoma), O’Shaughnessy (Ohio), Webber Falls Lock & Dam (Oklahoma), Barkley Hydro (Kentucky), and Dix Hydro (Kentucky), Keystone Hydro (Oklahoma), Table Rock Hydro (Missouri), Eufaula Hydro (Oklahoma), and Harry S. Truman Hydro (Missouri).

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Appendix 1. Protocol for the hydropower screening process developed for the U. S. Environmental Protection Agency's TMDL Tracking System, Mississippi River Basin – June 1999.

Step(s)	**Description**

(1) Load "MSSTATES" and open "MS BASINS2" database. "TMDL Tracking System" screen will appear. (Note: The database is accessible through Microsoft Access.)

(2) Navigate to screen labeled "MS BASINS2: Database". Activate "Queries" tab.

(3) Highlight "CAUSE" on screen and click on "New" to design a query for the database.

(4) Highlight "Simple Query Wizard" from New Query Screen and click "OK".

(5) Select "Table: LIST_INFO" from Tables/Queries. (Note: the LIST_INFO: Table contains 11,525 TMDL sites.) Highlight and move listing(s) from "Available Fields:" to "Selected Fields:". In this project the following fields were selected: LIST_ID, STATE, WBTYPE, BASIN, WBNAME, LOCATION, COMMENT, AND PRIORITY.

(6) After identifying "Selected Fields:" from the "Table: LIST_INFO" open the "Table: CAUSES" and move "LIST_ID" and "CAUSES" to "Selected Fields". (Note: This step will add the "CAUSE" column to the query which contains 23,554 TMDL sites.) Proceed to the next step by clicking on "Next".

(7) Select a "Detail" vs the "Summary" option. Click on "Next".

(8) Provide a title for query and click on "Finish". (Note: The query title is "Cause List 2")

(9) Highlight "Cause List 2" query which will appear as a new listing on the "MS BASINS2" screen and click on "Design". This will open the query and show the field(s) and how the two tables were linked. Navigate to the "CAUSES" column and identify water quality parameters that will be used to query the merged tables and their TMDL information. The basic water quality parameters used in this project were ORGAINC ENRICHMENT/LOW DISSOLVED OXYGEN, NUTRIENTS, THERMAL MODIFICATIONS, FLOW ALTERATIONS, AND AMMONIA. (Note: Use the "EPA_CAUSE" list in the "CAUS_LUT" to select water quality parameters.)

(10) Run “”Cause List 2” query. (Note: A new table was created which contains 6,296 TMDL files.)

(11) Use information in the “DRAFT INVENTORY OF DAMS – MISSISSIPPI RIVER BASIN, HYDROPOWER PROJECTS DATABASE” to select those TMDL sites that may be (i) adversely affected by hydropower releases, or (ii) may be contributing to poor water quality in the upstream watershed and reservoir. (Note: This step was done manually and resulted in a new database containing 182 TMDL files. The file name for this database is “hydro.tmdl.xls” which was created using Microsoft Excel.)

(12) Merge the “Cause List 2” query with “SOURCES: Table” in “MS BASINS2” to create a new query, “Cause List 3”. (Note: The new “Cause List 3” database with “SOURCES” contains 17,004 TMDL files.)

(13) Merge the database created by the “Cause List 3” query with the TMDL files in “hydro.tmdl.xls”.

(14) Open “hydro.tmdl.xls” and sort the data files by “BASIN” to create “**Appendix 2. Proposed list of candidate pollutant trading projects identified in the hydropower project survey of the Mississippi River Basin – June 1999**.” New file is titled “hydro.tmdl2.xls”.

(15) Open “hydro.tmdl.xls” and sort data files by “STATE” to create “**Appendix 3. List of state TMDL sites identified in the survey of hydropower projects experiencing water quality concerns, Mississippi River Basin – June 1999**.” New file is titled “hydro.tmdl3.xls”.

Appendix 2. Proposed list of candidate pollutant trading projects identified in the hydropower project survey of the Mississippi River Basin - July 2000.

LIST_ID	STATE	BASIN	WBNAME	CAUSE
KAW HYDRO				
OK621210000010-1998	OKLAHOMA	ARKANSAS/WHITE/RED/MIDDLE	ARKANSAS RIVER	NUTRIENTS
OK621210000020-1998	OKLAHOMA	ARKANSAS/WHITE/RED/MIDDLE	KAW LAKE (ARKANSAS RIVER)	ORGANIC ENRICHMENT/DO
OK621210000020-1998	OKLAHOMA	ARKANSAS/WHITE/RED/MIDDLE	KAW LAKE (ARKANSAS RIVER)	NUTRIENTS
OK621210000030-1998	OKLAHOMA	ARKANSAS/WHITE/RED/MIDDLE	ARKANSAS RIVER	NUTRIENTS
OK621210000030-1998	OKLAHOMA	ARKANSAS/WHITE/RED/MIDDLE	ARKANSAS RIVER	ORGANIC ENRICHMENT/DO
OK621210000040-1998	OKLAHOMA	ARKANSAS/WHITE/RED/MIDDLE	KAW LAKE, ARKANSAS RIVER ARM	NUTRIENTS
OK621210000040-1998	OKLAHOMA	ARKANSAS/WHITE/RED/MIDDLE	KAW LAKE, ARKANSAS RIVER ARM	ORGANIC ENRICHMENT/DO
OK621210000040-1998	OKLAHOMA	ARKANSAS/WHITE/RED/MIDDLE	KAW LAKE, ARKANSAS RIVER ARM	THERMAL STRATIFICATION
OK621210000040-1998	OKLAHOMA	ARKANSAS/WHITE/RED/MIDDLE	KAW LAKE, ARKANSAS RIVER ARM	FLOW ALTERATION
OK621210000060-1998	OKLAHOMA	ARKANSAS/WHITE/RED/MIDDLE	KAW LAKE, BEAVER CREEK ARM	NUTRIENTS
OK621210000060-1998	OKLAHOMA	ARKANSAS/WHITE/RED/MIDDLE	KAW LAKE, BEAVER CREEK ARM	THERMAL STRATIFICATION
OK621210000060-1998	OKLAHOMA	ARKANSAS/WHITE/RED/MIDDLE	KAW LAKE, BEAVER CREEK ARM	ORGANIC ENRICHMENT/DO
OK621210000060-1998	OKLAHOMA	ARKANSAS/WHITE/RED/MIDDLE	KAW LAKE, BEAVER CREEK ARM	FLOW ALTERATION
KEYSTONE HYDRO				
OK620900010090-1998	OKLAHOMA	ARKANSAS/WHITE/RED/MIDDLE	KEYSTONE LAKE, CIMARRON	ORGANIC ENRICHMENT/DO
OK620900010090-1998	OKLAHOMA	ARKANSAS/WHITE/RED/MIDDLE	KEYSTONE LAKE, CIMARRON	THERMAL STRATIFICATION
OK621200010010-1998	OKLAHOMA	ARKANSAS/WHITE/RED/MIDDLE	ARKANSAS RIVER	NUTRIENTS
OK621200010020-1998	OKLAHOMA	ARKANSAS/WHITE/RED/MIDDLE	KEYSTONE LAKE	FLOW ALTERATION
OK621200010020-1998	OKLAHOMA	ARKANSAS/WHITE/RED/MIDDLE	KEYSTONE LAKE	THERMAL STRATIFICATION
OK621200010020-1998	OKLAHOMA	ARKANSAS/WHITE/RED/MIDDLE	KEYSTONE LAKE	ORGANIC ENRICHMENT/DO
OK621200010020-1998	OKLAHOMA	ARKANSAS/WHITE/RED/MIDDLE	KEYSTONE LAKE	NUTRIENTS
OK621200010040-1998	OKLAHOMA	ARKANSAS/WHITE/RED/MIDDLE	ARKANSAS RIVER	NUTRIENTS
OK621200010050-1998	OKLAHOMA	ARKANSAS/WHITE/RED/MIDDLE	KEYSTONE LAKE, ARKANSAS	FLOW ALTERATION
OK621200010050-1998	OKLAHOMA	ARKANSAS/WHITE/RED/MIDDLE	KEYSTONE LAKE, ARKANSAS	ORGANIC ENRICHMENT/DO
OK621200010050-1998	OKLAHOMA	ARKANSAS/WHITE/RED/MIDDLE	KEYSTONE LAKE, ARKANSAS	THERMAL STRATIFICATION
OK621200010050-1998	OKLAHOMA	ARKANSAS/WHITE/RED/MIDDLE	KEYSTONE LAKE, ARKANSAS	NUTRIENTS
OK621200010200-1998	OKLAHOMA	ARKANSAS/WHITE/RED/MIDDLE	ARKANSAS RIVER	NUTRIENTS
PENSACOLA HYDRO				
OK121600030010-1998	OKLAHOMA	ARKANSAS/WHITE/RED/NEOSHO	NEOSHO (GRAND) RIVER	ORGANIC ENRICHMENT/DO
OK121600030010-1998	OKLAHOMA	ARKANSAS/WHITE/RED/NEOSHO	NEOSHO (GRAND) RIVER	NUTRIENTS
OK121600030020-1998	OKLAHOMA	ARKANSAS/WHITE/RED/NEOSHO	LAKE O' THE CHEROKEES (GRAND)	NUTRIENTS
OK121600030020-1998	OKLAHOMA	ARKANSAS/WHITE/RED/NEOSHO	LAKE O' THE CHEROKEES (GRAND)	ORGANIC ENRICHMENT/DO
OK121600030050-1998	OKLAHOMA	ARKANSAS/WHITE/RED/NEOSHO	NEOSHO (GRAND) RIVER	NUTRIENTS
OK121600030050-1998	OKLAHOMA	ARKANSAS/WHITE/RED/NEOSHO	NEOSHO (GRAND) RIVER	ORGANIC ENRICHMENT/DO

OK121600030060-1998	OKLAHOMA	ARKANSAS/WHITE/RED/NEOSHO	LAKE O' THE CHEROKEES (GRAND)	NUTRIENTS
OK121600030060-1998	OKLAHOMA	ARKANSAS/WHITE/RED/NEOSHO	LAKE O' THE CHEROKEES (GRAND)	ORGANIC ENRICHMENT/DO
OK121600030080-1998	OKLAHOMA	ARKANSAS/WHITE/RED/NEOSHO	DUCK CREEK COVE, GRAND LAKE	ORGANIC ENRICHMENT/DO
OK121600030080-1998	OKLAHOMA	ARKANSAS/WHITE/RED/NEOSHO	DUCK CREEK COVE, GRAND LAKE	NUTRIENTS
OK121600030140-1998	OKLAHOMA	ARKANSAS/WHITE/RED/NEOSHO	NEOSHO (GRAND) RIVER	NUTRIENTS
OK121600030140-1998	OKLAHOMA	ARKANSAS/WHITE/RED/NEOSHO	NEOSHO (GRAND) RIVER	ORGANIC ENRICHMENT/DO
OK121600030150-1998	OKLAHOMA	ARKANSAS/WHITE/RED/NEOSHO	LAKE O' THE CHEROKEES, LOWER MIDDLE	NUTRIENTS
OK121600030150-1998	OKLAHOMA	ARKANSAS/WHITE/RED/NEOSHO	LAKE O' THE CHEROKEES, LOWER MIDDLE	ORGANIC ENRICHMENT/DO
OK121600030210-1998	OKLAHOMA	ARKANSAS/WHITE/RED/NEOSHO	WEST BAY, GRAND LAKE	ORGANIC ENRICHMENT/DO
OK121600030210-1998	OKLAHOMA	ARKANSAS/WHITE/RED/NEOSHO	WEST BAY, GRAND LAKE	NUTRIENTS
OK121600030220-1998	OKLAHOMA	ARKANSAS/WHITE/RED/NEOSHO	CHIGGER COVE, GRAND LAKE	NUTRIENTS
OK121600030220-1998	OKLAHOMA	ARKANSAS/WHITE/RED/NEOSHO	CHIGGER COVE, GRAND LAKE	ORGANIC ENRICHMENT/DO
OK121600030260-1998	OKLAHOMA	ARKANSAS/WHITE/RED/NEOSHO	COURTHOUSE HOLLOW COVE, GRAND LAKE	ORGANIC ENRICHMENT/DO
OK121600030260-1998	OKLAHOMA	ARKANSAS/WHITE/RED/NEOSHO	COURTHOUSE HOLLOW COVE, GRAND LAKE	NUTRIENTS
OK121600030270-1998	OKLAHOMA	ARKANSAS/WHITE/RED/NEOSHO	NEOSHO (GRAND) RIVER	AMMONIA
OK121600030270-1998	OKLAHOMA	ARKANSAS/WHITE/RED/NEOSHO	NEOSHO (GRAND) RIVER	NUTRIENTS
OK121600030270-1998	OKLAHOMA	ARKANSAS/WHITE/RED/NEOSHO	NEOSHO (GRAND) RIVER	ORGANIC ENRICHMENT/DO
OK121600030280-1998	OKLAHOMA	ARKANSAS/WHITE/RED/NEOSHO	LAKE O' THE CHEROKEES, MIDDLE	NUTRIENTS
OK121600030280-1998	OKLAHOMA	ARKANSAS/WHITE/RED/NEOSHO	LAKE O' THE CHEROKEES, MIDDLE	AMMONIA
OK121600030290-1998	OKLAHOMA	ARKANSAS/WHITE/RED/NEOSHO	LAKE O' THE CHEROKEES, HONEY CREEK	NUTRIENTS
OK121600030290-1998	OKLAHOMA	ARKANSAS/WHITE/RED/NEOSHO	LAKE O' THE CHEROKEES, HONEY CREEK	AMMONIA
OK121600030290-1998	OKLAHOMA	ARKANSAS/WHITE/RED/NEOSHO	LAKE O' THE CHEROKEES, HONEY CREEK	ORGANIC ENRICHMENT/DO
OK121600030350-1998	OKLAHOMA	ARKANSAS/WHITE/RED/NEOSHO	ECHO BAY, GRAND LAKE	ORGANIC ENRICHMENT/DO
OK121600030350-1998	OKLAHOMA	ARKANSAS/WHITE/RED/NEOSHO	ECHO BAY, GRAND LAKE	AMMONIA
OK121600030350-1998	OKLAHOMA	ARKANSAS/WHITE/RED/NEOSHO	ECHO BAY, GRAND LAKE	NUTRIENTS
OK121600030360-1998	OKLAHOMA	ARKANSAS/WHITE/RED/NEOSHO	CAREY BAY, GRAND LAKE	AMMONIA
OK121600030360-1998	OKLAHOMA	ARKANSAS/WHITE/RED/NEOSHO	CAREY BAY, GRAND LAKE	NUTRIENTS
OK121600030360-1998	OKLAHOMA	ARKANSAS/WHITE/RED/NEOSHO	CAREY BAY, GRAND LAKE	ORGANIC ENRICHMENT/DO
OK121600030370-1998	OKLAHOMA	ARKANSAS/WHITE/RED/NEOSHO	NEOSHO (GRAND) RIVER	NUTRIENTS
OK121600030370-1998	OKLAHOMA	ARKANSAS/WHITE/RED/NEOSHO	NEOSHO (GRAND) RIVER	ORGANIC ENRICHMENT/DO
OK121600040010-1998	OKLAHOMA	ARKANSAS/WHITE/RED/NEOSHO	NEOSHO (GRAND) RIVER	ORGANIC ENRICHMENT/DO
ROBERT S. KERR HYDRO				
OK121600020010-1998	OKLAHOMA	ARKANSAS/WHITE/RED/NEOSHO	NEOSHO (GRAND) RIVER	ORGANIC ENRICHMENT/DO
OK121600020170-1998	OKLAHOMA	ARKANSAS/WHITE/RED/NEOSHO	NEOSHO (GRAND) RIVER	ORGANIC ENRICHMENT/DO
FORT GIBSON HYDRO				
OK121600010040-1998	OKLAHOMA	ARKANSAS/WHITE/RED/NEOSHO	NEOSHO (GRAND) RIVER	NUTRIENTS
OK121600010050-1998	OKLAHOMA	ARKANSAS/WHITE/RED/NEOSHO	FORT GIBSON LAKE	NUTRIENTS
OK121600010150-1998	OKLAHOMA	ARKANSAS/WHITE/RED/NEOSHO	JACKSON BAY, FT. GIBSON LAKE	NUTRIENTS
OK121600010170-1998	OKLAHOMA	ARKANSAS/WHITE/RED/NEOSHO	LONG BAY, FT. GIBSON LAKE	NUTRIENTS

OK121600010180-1998	OKLAHOMA	ARKANSAS/WHITE/RED/NEOSHO	NORTH BAY, FT. GIBSON LAKE	NUTRIENTS
OK121600010190-1998	OKLAHOMA	ARKANSAS/WHITE/RED/NEOSHO	NEOSHO (GRAND) RIVER	ORGANIC ENRICHMENT/DO
OK121600010280-1998	OKLAHOMA	ARKANSAS/WHITE/RED/NEOSHO	NEOSHO (GRAND) RIVER	ORGANIC ENRICHMENT/DO
WEBBER FALLS L&D				
OK621200020010-1998	OKLAHOMA	ARKANSAS/WHITE/RED/MIDDLE	ARKANSAS RIVER	NUTRIENTS
OK120400010010-1998	OKLAHOMA	ARKANSAS/WHITE/RED/MIDDLE	ARKANSAS RIVER	ORGANIC ENRICHMENT/DO
OK120400010010-1998	OKLAHOMA	ARKANSAS/WHITE/RED/MIDDLE	ARKANSAS RIVER	NUTRIENTS
OK120400010060-1998	OKLAHOMA	ARKANSAS/WHITE/RED/MIDDLE	ARKANSAS RIVER	ORGANIC ENRICHMENT/DO
OK120400010060-1998	OKLAHOMA	ARKANSAS/WHITE/RED/MIDDLE	ARKANSAS RIVER	NUTRIENTS
TENKILLER HYDRO				
OK121700010010-1998	OKLAHOMA	ARKANSAS/WHITE/RED/ILLINOIS	ILLINOIS RIVER	FLOW ALTERATION
OK121700010010-1998	OKLAHOMA	ARKANSAS/WHITE/RED/ILLINOIS	ILLINOIS RIVER	ORGANIC ENRICHMENT/DO
OK121700020010-1998	OKLAHOMA	ARKANSAS/WHITE/RED/ILLINOIS	ILLINOIS RIVER	ORGANIC ENRICHMENT/DO
OK121700020010-1998	OKLAHOMA	ARKANSAS/WHITE/RED/ILLINOIS	ILLINOIS RIVER	FLOW ALTERATION
OK121700020020-1998	OKLAHOMA	ARKANSAS/WHITE/RED/ILLINOIS	TENKILLER FERRY LAKE	NUTRIENTS
OK121700020020-1998	OKLAHOMA	ARKANSAS/WHITE/RED/ILLINOIS	TENKILLER FERRY LAKE	FLOW ALTERATION
OK121700020020-1998	OKLAHOMA	ARKANSAS/WHITE/RED/ILLINOIS	TENKILLER FERRY LAKE	ORGANIC ENRICHMENT/DO
OK121700020210-1998	OKLAHOMA	ARKANSAS/WHITE/RED/ILLINOIS	ILLINOIS RIVER	FLOW ALTERATION
OK121700020210-1998	OKLAHOMA	ARKANSAS/WHITE/RED/ILLINOIS	ILLINOIS RIVER	ORGANIC ENRICHMENT/DO
OK121700020300-1998	OKLAHOMA	ARKANSAS/WHITE/RED/ILLINOIS	ILLINOIS RIVER	ORGANIC ENRICHMENT/DO
OK121700020300-1998	OKLAHOMA	ARKANSAS/WHITE/RED/ILLINOIS	ILLINOIS RIVER	NUTRIENTS
OK121700030010-1998	OKLAHOMA	ARKANSAS/WHITE/RED/ILLINOIS	ILLINOIS RIVER	ORGANIC ENRICHMENT/DO
OK121700030010-1998	OKLAHOMA	ARKANSAS/WHITE/RED/ILLINOIS	ILLINOIS RIVER	NUTRIENTS
OK121700030080-1998	OKLAHOMA	ARKANSAS/WHITE/RED/ILLINOIS	ILLINOIS RIVER	NUTRIENTS
OK121700030080-1998	OKLAHOMA	ARKANSAS/WHITE/RED/ILLINOIS	ILLINOIS RIVER	ORGANIC ENRICHMENT/DO
OK121700030280-1998	OKLAHOMA	ARKANSAS/WHITE/RED/ILLINOIS	ILLINOIS RIVER	NUTRIENTS
OK121700030280-1998	OKLAHOMA	ARKANSAS/WHITE/RED/ILLINOIS	ILLINOIS RIVER	ORGANIC ENRICHMENT/DO
OK121700030350-1998	OKLAHOMA	ARKANSAS/WHITE/RED/ILLINOIS	ILLINOIS RIVER	NUTRIENTS
EUFAULA HYDRO				
OK220600010020-1998	OKLAHOMA	ARKANSAS/WHITE/RED/LOWER	EUFAULA LAKE	FLOW ALTERATION
OK220600010090-1998	OKLAHOMA	ARKANSAS/WHITE/RED/LOWER	EUFAULA LAKE, MILL CREEK ARM	NUTRIENTS
OK220600010090-1998	OKLAHOMA	ARKANSAS/WHITE/RED/LOWER	EUFAULA LAKE, MILL CREEK ARM	AMMONIA
OK520500010020-1998	OKLAHOMA	ARKANSAS/WHITE/RED/LOWER	EUFAULA LAKE, CANADIAN RIVER ARM, (LWF	ORGANIC ENRICHMENT/DO
OK220200010010-1998	OKLAHOMA	ARKANSAS/WHITE/RED/MIDDLE	ARKANSAS RIVER	ORGANIC ENRICHMENT/DO
OK220200020010-1998	OKLAHOMA	ARKANSAS/WHITE/RED/MIDDLE	ARKANSAS RIVER	ORGANIC ENRICHMENT/DO
DENISON DAM HYDRO				
OK310800010050-1998	OKLAHOMA	ARKANSAS/WHITE/RED/RED	TEXOMA LAKE, WASHITA RIVER	NUTRIENTS

OK311100010030-1998	OKLAHOMA	ARKANSAS/WHITE/RED/RED	TEXOMA LAKE, RED RIVER ARM, LOWER	NUTRIENTS
OK311100010080-1998	OKLAHOMA	ARKANSAS/WHITE/RED/RED	TEXOMA LAKE, RED RIVER ARM, LOWER	NUTRIENTS
BROKEN BOW HYDRO				
OK410210020010-1998	OKLAHOMA	ARKANSAS/WHITE/RED/BBMFLR	LITTLE RIVER	NUTRIENTS
OK410210050010-1998	OKLAHOMA	ARKANSAS/WHITE/RED/BBMFLR	MOUNTAIN FORK RIVER, MIDDLE	ORGANIC ENRICHMENT/DO
OK410210050020-1998	OKLAHOMA	ARKANSAS/WHITE/RED/BBMFLR	BROKEN BOW LAKE	ORGANIC ENRICHMENT/DO
OK410210050020-1998	OKLAHOMA	ARKANSAS/WHITE/RED/BBMFLR	BROKEN BOW LAKE	NUTRIENTS
YELLOWTAIL HYDRO				
MT43P0051-1998	MONTANA	MISSOURI/BIGHORN	BIGHORN R	ORGANIC ENRICHMENT/LOW DISSC
MT43P0051-1998	MONTANA	MISSOURI/BIGHORN	BIGHORN R	THERMAL MODIFICATIONS
MT43P0051-1998	MONTANA	MISSOURI/BIGHORN	BIGHORN R	FLOW ALTERATION
CANYON FERRY/HOLTER				
MT41I00071-1998	MONTANA	MISSOURI/UPPER	HOLTER LAKE	NUTRIENTS
MT41I0031-1998	MONTANA	MISSOURI/UPPER	CANYON FERRY RESERVOIR	NUTRIENTS
MT41Q0011-1998	MONTANA	MISSOURI/UPPER	MISSOURI R	FLOW ALTERATION
MT41Q0011-1998	MONTANA	MISSOURI/UPPER	MISSOURI R	NUTRIENTS
FORT PECK HYDRO				
MT40E0011-1998	MONTANA	MISSOURI/UPPER	FORT PECK RESERVOIR	FLOW ALTERATIONS
MT40E0011-1998	MONTANA	MISSOURI/UPPER	FORT PECK RESERVOIR	NUTRIENTS
MT40E0011-1998	MONTANA	MISSOURI/UPPER	FORT PECK RESERVOIR	ORGANIC ENRICHMENT/LOW DISSC
HOLMESVILLE/BLUE SPRING				
NE-BB1-10000-1998	NEBRASKA	MISSOURI/BIGBLUE	BIG BLUE RIVER	AMMONIA (UN-IONIZED)
NE-BB1-10000-1998	NEBRASKA	MISSOURI/BIGBLUE	BIG BLUE RIVER	AMMONIA (UN-IONIZED)
TRUMAN HYDRO				
MO-7205-1998	MISSOURI	LOWER MISSSOURI		LOW DISSOLVED OXYGEN
MO-7205-1998	MISSOURI	LOWER MISSSOURI		GASEOUS SUPERSATURATION
TABLE ROCK HYDRO				
MO-7514-1998	MISSOURI	LOWER MISSOURI		LOW DISSOLVED OXYGEN
CLARENCE CANNON HYDRO				
MO-7033-1998	MISSOURI	LOWER MISSOURI		ATRAZINE/LOW DISSOLVED OXYGE
EAU GALLE RIVER				
WI-LC-109-093-Eau_Galle_River-1998	WISCONSIN	UPPER MISSISSIPPI/EAUGALLE	EAU GALLE RIVER	THERMAL MODIFICATIONS

WI-LC-109-093-Eau_Galle_River-1998	WISCONSIN	UPPER MISSISSIPPI/EAUGALLE	EAU GALLE RIVER	NUTRIENTS
ANAMOSA HYDRO				
IA 01-WPS-0010(A)_1998	IOWA	UPPER MISSISSIPPI/WAPS	WAPSIPINICON RIVER, LONG GROVE	AMMONIA
IA 01-WPS-0010(B)_1998	IOWA	UPPER MISSISSIPPI/WAPS	WAPSIPINICON RIVER, PARK VIEW	AMMONIA
WAVERLY MILLDAM HYDRO				
IA 02-CED-0010(A)_1998	IOWA	UPPER MISSISSIPPI/CEDAR	CEDAR RIVER, CEDAR FALLS	AMMONIA
IA 02-CED-0010(B)_1998	IOWA	UPPER MISSISSIPPI/CEDAR	CEDAR RIVER, CEDAR FALLS	AMMONIA
IA 02-CED-0010(C)_1998	IOWA	UPPER MISSISSIPPI/CEDAR	CEDAR RIVER, LA PORTE	AMMONIA
	IOWA	UPPER MISSISSIPPI/CEDAR	CEDAR RIVER, WATERLOO	AMMONIA
IOWA FALLS MILLDAM				
IA 02-IOW-0030(B)_1998	IOWA	UPPER MISSISSIPPI/IOWA	IOWA RIVER, MODERN MANOR	AMMONIA
IA 02-IOW-0050(B)_1998	IOWA	UPPER MISSISSIPPI/IOWA	IOWA RIVER	AMMONIA
IA 02-IOW-0060_1998	IOWA	UPPER MISSISSIPPI/IOWA	IOWA RIVER, MARSHALLTOWN	AMMONIA
LOCK & DAM 19 HYDRO				
IA 03-SKM-0010_1998	IOWA	UPPER MISSISSIPPI	MISSISSIPIPI RIVER	AMMONIA
IA 03-SKM-0010-1(B)_1998	IOWA	UPPER MISSISSIPPI	MISSISSIPPI R	AMMONIA-NITROGEN
IA 03-SKM-0010-1_1998	IOWA	UPPER MISSISSIPPI	MISSISSIPPI RIVER	AMMONIA-NITROGEN
DAYTON HYDRO				
ILCH01_CH 11-1998	ILLINOIS	UPPER MISSISSIPPI/FOX	FOX R	ORGANIC ENRICHMENT/DO
ILCH01_CH 11-1998	ILLINOIS	UPPER MISSISSIPPI/FOX	FOX R	NUTRIENTS
ILRTF-1998	ILLINOIS	UPPER MISSISSIPPI/FOX	FOX	NUTRIENTS
ROCKTON,DIXON,&SEARS				
ILP04_P 24-1998	ILLINOIS	UPPER MISSISSIPPI/ROCK	ROCK R	NUTRIENTS
ILP04_P 25-1998	ILLINOIS	UPPER MISSISSIPPI/ROCK	ROCK R	NUTRIENTS
ILP04_P 25-1998	ILLINOIS	UPPER MISSISSIPPI/ROCK	ROCK R	FLOW ALTERATIONS
ILP06_P 21-1998	ILLINOIS	UPPER MISSISSIPPI/ROCK	ROCK R	FLOW ALTERATIONS
CHIC SAN & SHIP CHANNEL				
ILGI02_GI 02-1998	ILLINOIS	UPPER MISSISSIPPI/CHICAGO	CHIC SAN & SHIP CANAL	FLOW ALTERATIONS
ILGI02_GI 02-1998	ILLINOIS	UPPER MISSISSIPPI/CHICAGO	CHIC SAN & SHIP CANAL	AMMONIA
ILGI02_GI 02-1998	ILLINOIS	UPPER MISSISSIPPI/CHICAGO	CHIC SAN & SHIP CANAL	ORGANIC ENRICHMENT/DO
ILGI02_GI 02-1998	ILLINOIS	UPPER MISSISSIPPI/CHICAGO	CHIC SAN & SHIP CANAL	NUTRIENTS
ILGI02_GI 04-1998	ILLINOIS	UPPER MISSISSIPPI/CHICAGO	CHIC SAN & SHIP CANAL	AMMONIA
ILGI02_GI 04-1998	ILLINOIS	UPPER MISSISSIPPI/CHICAGO	CHIC SAN & SHIP CANAL	NUTRIENTS
ILGI02_GI 04-1998	ILLINOIS	UPPER MISSISSIPPI/CHICAGO	CHIC SAN & SHIP CANAL	ORGANIC ENRICHMENT/DO

ILGI02_GI 04-1998	ILLINOIS	UPPER MISSISSIPPI/CHICAGO	CHIC SAN & SHIP CANAL	FLOW ALTERATIONS
ILGI02_GI 05-1998	ILLINOIS	UPPER MISSISSIPPI/CHICAGO	CHIC SAN & SHIP CANAL	ORGANIC ENRICHMENT/DO
ILGI02_GI 05-1998	ILLINOIS	UPPER MISSISSIPPI/CHICAGO	CHIC SAN & SHIP CANAL	NUTRIENTS
ILGI02_GI 05-1998	ILLINOIS	UPPER MISSISSIPPI/CHICAGO	CHIC SAN & SHIP CANAL	AMMONIA
ILGI02_GI 05-1998	ILLINOIS	UPPER MISSISSIPPI/CHICAGO	CHIC SAN & SHIP CANAL	FLOW ALTERATIONS
ILGI02_GI 06-1998	ILLINOIS	UPPER MISSISSIPPI/CHICAGO	CHIC SAN & SHIP CANAL	AMMONIA
ILGI02_GI 06-1998	ILLINOIS	UPPER MISSISSIPPI/CHICAGO	CHIC SAN & SHIP CANAL	NUTRIENTS
ILGI02_GI 06-1998	ILLINOIS	UPPER MISSISSIPPI/CHICAGO	CHIC SAN & SHIP CANAL	ORGANIC ENRICHMENT/DO
ILGI02_GI 06-1998	ILLINOIS	UPPER MISSISSIPPI/CHICAGO	CHIC SAN & SHIP CANAL	FLOW ALTERATIONS
ILGI03_GI 03-1998	ILLINOIS	UPPER MISSISSIPPI/CHICAGO	CHIC SAN & SHIP CANAL	ORGANIC ENRICHMENT/DO
ILGI03_GI 03-1998	ILLINOIS	UPPER MISSISSIPPI/CHICAGO	CHIC SAN & SHIP CANAL	AMMONIA
ILGI03_GI 03-1998	ILLINOIS	UPPER MISSISSIPPI/CHICAGO	CHIC SAN & SHIP CANAL	NUTRIENTS

MISSISSIPPI RIVER HYDRO

ILI01_I 01-1998	ILLINOIS	UPPER MISSISSIPPI	MISSISSIPPI R	NUTRIENTS
ILI01_I 98-1998	ILLINOIS	UPPER MISSISSIPPI	MISSISSIPPI R	NUTRIENTS
ILI01_TI 05-1998	ILLINOIS	UPPER MISSISSIPPI	MISSISSIPPI R	NUTRIENTS
ILI01_TI 06-1998	ILLINOIS	UPPER MISSISSIPPI	MISSISSIPPI R	NUTRIENTS
ILI01_TI 08-1998	ILLINOIS	UPPER MISSISSIPPI	MISSISSIPPI R	NUTRIENTS
ILI02_I 02-1998	ILLINOIS	UPPER MISSISSIPPI	MISSISSIPPI R	NUTRIENTS
ILI84_I 81-1998	ILLINOIS	UPPER MISSISSIPPI	MISSISSIPPI R	NUTRIENTS
ILI84_I 84-1998	ILLINOIS	UPPER MISSISSIPPI	MISSISSIPPI R	NUTRIENTS
ILI84_TI 01-1998	ILLINOIS	UPPER MISSISSIPPI	MISSISSIPPI R	NUTRIENTS
ILI84_TI 03-1998	ILLINOIS	UPPER MISSISSIPPI	MISSISSIPPI R	NUTRIENTS
ILI84_TI 04-1998	ILLINOIS	UPPER MISSISSIPPI	MISSISSIPPI R	NUTRIENTS
ILJ03_J 03-1998	ILLINOIS	UPPER MISSISSIPPI	MISSISSIPPI R	NUTRIENTS
ILJ03_J 96-1998	ILLINOIS	UPPER MISSISSIPPI	MISSISSIPPI R	NUTRIENTS
ILJ03_TJ 05-1998	ILLINOIS	UPPER MISSISSIPPI	MISSISSIPPI R	NUTRIENTS
ILJ03_TJ 06-1998	ILLINOIS	UPPER MISSISSIPPI	MISSISSIPPI R	NUTRIENTS
ILJ81_J 01-1998	ILLINOIS	UPPER MISSISSIPPI	MISSISSIPPI R	NUTRIENTS
ILJ81_J 81-1998	ILLINOIS	UPPER MISSISSIPPI	MISSISSIPPI R	NUTRIENTS
ILJ81_J 82-1998	ILLINOIS	UPPER MISSISSIPPI	MISSISSIPPI R	NUTRIENTS
ILJ81_TJ 12-1998	ILLINOIS	UPPER MISSISSIPPI	MISSISSIPPI R	NUTRIENTS
ILJ81_TJ 17-1998	ILLINOIS	UPPER MISSISSIPPI	MISSISSIPPI R	NUTRIENTS
ILJ83_J 83-1998	ILLINOIS	UPPER MISSISSIPPI	MISSISSIPPI R	NUTRIENTS
ILJ83_TJ 04-1998	ILLINOIS	UPPER MISSISSIPPI	MISSISSIPPI R	NUTRIENTS
ILJ83_TJ 13-1998	ILLINOIS	UPPER MISSISSIPPI	MISSISSIPPI R	NUTRIENTS
ILJ83_TJ 14-1998	ILLINOIS	UPPER MISSISSIPPI	MISSISSIPPI R	FLOW ALTERATIONS
ILJ83_TJ 14-1998	ILLINOIS	UPPER MISSISSIPPI	MISSISSIPPI R	NUTRIENTS
ILJ83_TJ 15-1998	ILLINOIS	UPPER MISSISSIPPI	MISSISSIPPI R	FLOW ALTERATIONS
ILJ83_TJ 15-1998	ILLINOIS	UPPER MISSISSIPPI	MISSISSIPPI R	NUTRIENTS

ILJ83_TJ 16-1998	ILLINOIS	UPPER MISSISSIPPI	MISSISSIPPI R	NUTRIENTS
ILJ83_TJ 16-1998	ILLINOIS	UPPER MISSISSIPPI	MISSISSIPPI R	FLOW ALTERATIONS
ILK01_K 09-1998	ILLINOIS	UPPER MISSISSIPPI	MISSISSIPPI R	NUTRIENTS
ILK01_K 98-1998	ILLINOIS	UPPER MISSISSIPPI	MISSISSIPPI R	NUTRIENTS
ILK01_TK 07-1998	ILLINOIS	UPPER MISSISSIPPI	MISSISSIPPI R	NUTRIENTS
ILK02_TK 12-1998	ILLINOIS	UPPER MISSISSIPPI	MISSISSIPPI R	NUTRIENTS
ILK06_K 02-1998	ILLINOIS	UPPER MISSISSIPPI	MISSISSIPPI R	NUTRIENTS
ILK06_TK 01-1998	ILLINOIS	UPPER MISSISSIPPI	MISSISSIPPI R	NUTRIENTS
ILK06_TK 02-1998	ILLINOIS	UPPER MISSISSIPPI	MISSISSIPPI R	NUTRIENTS
ILK07_K 05-1998	ILLINOIS	UPPER MISSISSIPPI	MISSISSIPPI R	NUTRIENTS
ILK07_K 14-1998	ILLINOIS	UPPER MISSISSIPPI	MISSISSIPPI R	NUTRIENTS
ILK07_TK 04-1998	ILLINOIS	UPPER MISSISSIPPI	MISSISSIPPI R	NUTRIENTS
ILK07_TK 06-1998	ILLINOIS	UPPER MISSISSIPPI	MISSISSIPPI R	NUTRIENTS
DIX RIVER HYDRO				
KY21012101-1998	KENTUCKY	OHIO/KENTUCKY	HERRINGTON LAKE	ORGANIC ENRICHMENT/LOW DO
O'SHAUGHNESSY HYDRO				
OH37 19-132-1998	OHIO	OHIO/SCIOTO	J. GRIGGS RESERVOIR	ORGANIC ENRICHMENT/DO
OH37 19-132-1998	OHIO	OHIO/SCIOTO	J. GRIGGS RESERVOIR	NUTRIENTS
OH37 25-101-1998	OHIO	OHIO/SCIOTO	O'SHAUGHNESSY RESERVOIR	NUTRIENTS
OH38 20-1998	OHIO	OHIO/SCIOTO	BIG WALNUT CREEK (HOOVER RES. DAM TO	FLOW ALTERATION
OH38 20-1998	OHIO	OHIO/SCIOTO	BIG WALNUT CREEK (HOOVER RES. DAM TO	THERMAL MODIFICATION
OH41 15-298-1998	OHIO	OHIO/SCIOTO	DEER CREEK LAKE	ORGANIC ENRICHMENT/DO
OH41 15-298-1998	OHIO	OHIO/SCIOTO	DEER CREEK LAKE	NUTRIENTS
OH41 15-298-1998	OHIO	OHIO/SCIOTO	DEER CREEK LAKE	AMMONIA
OH41 30-228-1998	OHIO	OHIO/SCIOTO	MADISON LAKE	ORGANIC ENRICHMENT/DO
OH41 30-228-1998	OHIO	OHIO/SCIOTO	MADISON LAKE	NUTRIENTS
OH41 39-1998	OHIO	OHIO/SCIOTO	HARGUS CREEK	ORGANIC ENRICHMENT/DO
OH41 39-299-1998	OHIO	OHIO/SCIOTO	HARGUS LAKE	FLOW ALTERATION
OH41 39-299-1998	OHIO	OHIO/SCIOTO	HARGUS LAKE	AMMONIA
OH41 39-299-1998	OHIO	OHIO/SCIOTO	HARGUS LAKE	ORGANIC ENRICHMENT/DO
OH41 39-299-1998	OHIO	OHIO/SCIOTO	HARGUS LAKE	NUTRIENTS
OH42 1-186-1998	OHIO	OHIO/SCIOTO	PAINT CREEK LAKE	ORGANIC ENRICHMENT/DO
OH42 1-186-1998	OHIO	OHIO/SCIOTO	PAINT CREEK LAKE	NUTRIENTS
OH43 44-185-1998	OHIO	OHIO/SCIOTO	ROCKY FORK LAKE	NUTRIENTS
OH43 49-187-1998	OHIO	OHIO/SCIOTO	HILLSBORO RESERVOIR	ORGANIC ENRICHMENT/DO
CENTER HILL HYDRO				
TN05130104048-1998	TENNESSEE	OHIO/UCUMBERLAND	PINE CREEK	ORGANIC ENRICHMENT/LOW DO
TN05130105001-1998	TENNESSEE	OHIO/UCUMBERLAND	OBEY RIVER	FLOW ALTERATIONS

TN05130108012-1998	TENNESSEE	OHIO/UCUMBERLAND	CANEY FORK RIVER	ORGANIC ENRICHMENT/LOW DO
TN05130108012-1998	TENNESSEE	OHIO/UCUMBERLAND	CANEY FORK RIVER	THERMAL MODIFICATIONS
TN05130108012-1998	TENNESSEE	OHIO/UCUMBERLAND	CANEY FORK RIVER	FLOW ALTERATIONS
TN051301080465.8-1998	TENNESSEE	OHIO/UCUMBERLAND	FALLING WATER RIV	ORGANIC ENRICHMENT/LOW DO
HICKORY/PRIEST/CHEATHAM				
TN05130202006T-1998	TENNESSEE	OHIO/LCUMBERLAND	CHEATHAM RESERVOIR TRIBS	ORGANIC ENRICHMENT/LOW DO
TN05130202009-1998	TENNESSEE	OHIO/LCUMBERLAND	CHEATHAM RES	ORGANIC ENRICHMENT/LOW DO
TN05130202009T-1998	TENNESSEE	OHIO/LCUMBERLAND	CHEATHAM RESERVOIR TRIBS	ORGANIC ENRICHMENT/LOW DO
TN05130203001-1998	TENNESSEE	OHIO/LCUMBERLAND	STONES RIVER	FLOW ALTERATIONS
TN05130203001-1998	TENNESSEE	OHIO/LCUMBERLAND	STONES RIVER	ORGANIC ENRICHMENT/LOW DO
TN05130203018-1998	TENNESSEE	OHIO/LCUMBERLAND	WEST FORK STONES RIVER	ORGANIC ENRICHMENT/LOW DO
BARKLEY HYDRO				
KY21016024-1998	KENTUCKY	OHIO/LCUMBERLAND	LITTLE RIVER	NUTRIENTS
SOUTH FORK HOLSTON				
VAS-O02R-1998	VIRGINIA	TENNESSEE/HOLSTON	SOUTH FORK HOLSTON RIVER - UT	AMMONIA
FORT PAT. HENRY HYDRO				
TN06010102001-1998	TENNESSEE	TENNESSEE/HOLSTON	SOUTH HOLSTON RIVER	THERMAL MODIFICATIONS
CHEROKEE HYDRO				
TN06010104003-1998	TENNESSEE	TENNESSEE/HOLSTON	HOLSTON RIVER	ORGANIC ENRICHMENT/LOW DO
WATAUGA LAKE				
TN05130202WATGAL-1998	TENNESSEE	TENNESSEE/HOLSTON/WATAUGA	WATAUGA LAKE	NUTRIENTS
TN05130202WATGAL-1998	TENNESSEE	TENNESSEE/HOLSTON/WATAUGA	WATAUGA LAKE	ORGANIC ENRICHMENT/LOW DO
DOUGLAS HYDRO				
TN06010107001-1998	TENNESSEE	TENNESSEE/FENCHBROAD	FRENCH BROAD R	NUTRIENTS
TN06010107001-1998	TENNESSEE	TENNESSEE/FENCHBROAD	FRENCH BROAD R	FLOW ALTERATIONS
TN06010107006-1998	TENNESSEE	TENNESSEE/FENCHBROAD	FRENCH BROAD R	ORGANIC ENRICHMENT/LOW DO
TN06010107006-1998	TENNESSEE	TENNESSEE/FENCHBROAD	FRENCH BROAD R	THERMAL MODIFICATIONS
TN06010107006-1998	TENNESSEE	TENNESSEE/FENCHBROAD	FRENCH BROAD R	FLOW ALTERATIONS
FORT LOUDOUN HYDRO				
TN06010201016-b-1998	TENNESSEE	TENNESSEE/UPPER	TENNESSEE RIVER	FLOW ALTERATIONS
TN06010201020-1998	TENNESSEE	TENNESSEE/UPPER	FORT LOUDOUN RESERVOIR	NUTRIENTS
TN06010201026-1998	TENNESSEE	TENNESSEE/UPPER	LITTLE RIVER	NUTRIENTS

GUNTERSVILLE HYDRO				
AL/06030001-170-01-1998	ALABAMA	TENNESSEE/MIDDLE	MUD CREEK	ORGANIC ENRICHMENT/DO
AL/06030001-270-01-1998	ALABAMA	TENNESSEE/MIDDLE	SCARHAM CREEK	AMMONIA
AL/06030001-270-01-1998	ALABAMA	TENNESSEE/MIDDLE	SCARHAM CREEK	ORGANIC ENRICHMENT/DO
TIM'S FORD HYDRO				
TN06030003015-1998	TENNESSEE	TENNESSEE/ELK	ELK RIVER	ORGANIC ENRICHMENT/LOW DO
TN06030003015-1998	TENNESSEE	TENNESSEE/ELK	ELK RIVER	FLOW ALTERATIONS
TN06030003015-1998	TENNESSEE	TENNESSEE/ELK	ELK RIVER	THERMAL MODIFICATIONS
TN06030003035-1998	TENNESSEE	TENNESSEE/ELK	ELK RIVER	ORGANIC ENRICHMENT/LOW DO
TN06030003035-1998	TENNESSEE	TENNESSEE/ELK	ELK RIVER	FLOW ALTERATIONS
TN06030003053-1998	TENNESSEE	TENNESSEE/ELK	ROCK CREEK	ORGANIC ENRICHMENT/LOW DO
TN06030003053-1998	TENNESSEE	TENNESSEE/ELK	ROCK CREEK	FLOW ALTERATIONS
TN06030003053-1998	TENNESSEE	TENNESSEE/ELK	ROCK CREEK	THERMAL MODIFICATIONS
WHEELER HYDRO				
AL/06030002-230-01-1998	ALABAMA	TENNESSEE/MIDDLE	ALDRIDGE CREEK	ORGANIC ENRICHMENT/DO
AL/06030002-410-01-1998	ALABAMA	TENNESSEE/MIDDLE	MALLARD CREEK	ORGANIC ENRICHMENT/DO
AL/06030004-150-01-1998	ALABAMA	TENNESSEE/MIDDLE	ELK RIVER	ORGANIC ENRICHMENT/DO
AL/06030004-450-01-1998	ALABAMA	TENNESSEE/MIDDLE	TENNESSEE RIVER	THERMAL MODIFICATIONS
AL/06030005-010-01-1998	ALABAMA	TENNESSEE/MIDDLE	BIG NANCE CREEK	AMMONIA
AL/06030005-010-01-1998	ALABAMA	TENNESSEE/MIDDLE	BIG NANCE CREEK	ORGANIC ENRICHMENT/DO
WILSON RESERVOIR				
AL/06030005-040-01-1998	ALABAMA	TENNESSEE/MIDDLE	TOWN CREEK	ORGANIC ENRICHMENT/DO
PICKWICK HYDRO - AL				
AL/06030005-160-01-1998	ALABAMA	TENNESSEE/MIDDLE	POND CREEK	ORGANIC ENRICHMENT/DO
PICKWICK HYDRO - MS				
MS192IE-1998	MISSISSIPPI	TENNESSEE/MIDDLE	INDIAN CREEK- DA	NUTRIENTS
MS192IE-1998	MISSISSIPPI	TENNESSEE/MIDDLE	INDIAN CREEK- DA	ORGANIC ENRICHMENT/LOW DO
MS193YE-1998	MISSISSIPPI	TENNESSEE/MIDDLE	YELLOW CREEK- DA	NUTRIENTS
MS194E-1998	MISSISSIPPI	TENNESSEE/MIDDLE	BEAR CREEK- DA	ORGANIC ENRICHMENT/LOW DO
KENTUCKY HYDRO				
TN06040005022-1998	TENNESSEE	TENNESSEE/LOWER	WEST SANDY EMBAYMENT	NUTRIENTS
TN06040005022-1998	TENNESSEE	TENNESSEE/LOWER	WEST SANDY EMBAYMENT	ORGANIC ENRICHMENT/LOW DO

Appendix 3. List of state TMDL sites identified in the survey of hydropower projects experiencing water quality concerns, Mississippi River Basin - July 2000.

LIST_ID	STATE	WBTYPE	BASIN	WBNAME	LOCATION	COMMENT	PRIORITY	CAUSE	SOURCE
AL/06030001-270-01-1998	ALABAMA	STREAM/CREEK/RIVER	TENNESSEE	SCARHAM CREEK	MARSHALL	SHORT CREEK/ITS SOURE	HIGH	AMMONIA	NON-IRR CROP PROD, SPEC CROP PROD, ANIMAL FEEDING OPS, PASTURE GRAZING
AL/06030001-170-01-1998	ALABAMA	STREAM/CREEK/RIVER	TENNESSEE	MUD CREEK	JACKSON	TENNESEE RIVER/ITS SOURCE	LOW	ORGANIC ENRICHMENT/ DO	NON-IRR CROP PROD, PASTURE GRAZING
AL/06030004-450-01-1998	ALABAMA	STREAM/CREEK/RIVER	TENNESSEE	TENNESSEE RIVER	LAWRENCE	WHEELER DAM/ELK RIVER	LOW	THERMAL MODIFICATIO NS	INDUSTRIAL, FLOW REGULATION/MODIFI CATION
AL/06030004-150-01-1998	ALABAMA	STREAM/CREEK/RIVER	TENNESSEE	ELK RIVER	LIMESTONE	WHEELER RESERVOIR/AND ERSON CREEK	LOW	ORGANIC ENRICHMENT/ DO	PASTURE GRAZING, NONIRRIGATED CROP PRODUCTION
AL/06030002-410-01-1998	ALABAMA	STREAM/CREEK/RIVER	TENNESSEE	MALLARD CREEK	LAWRENCE	WHEELER RESERVOIR/11.5 MILES UPSTREAM	LOW	ORGANIC ENRICHMENT/ DO	AGRICULTURE
AL/06030002-270-01-1998	ALABAMA	STREAM/CREEK/RIVER	TENNESSEE	TOWN CREEK	MORGAN	COTACO CREEK/ITS SOURCE	HIGH	ORGANIC ENRICHMENT/ DO	AGRICULTURE
AL/06030005-160-01-1998	ALABAMA	STREAM/CREEK/RIVER	TENNESSEE	POND CREEK	COLBERT	TENNESSEE RIVER/ITS SOURCE	LOW	ORGANIC ENRICHMENT/ DO	NONIRRIGATED CROP PRODUCTION, URBAN RUNOFF/STORM SEWERS, NATURAL SOURCES
AL/06030005-040-01-1998	ALABAMA	STREAM/CREEK/RIVER	TENNESSEE	TOWN CREEK	FRANKLIN	WHEELER RESERVOIR/ITS SOURCE	HIGH	ORGANIC ENRICHMENT/ DO	NONIRRIGATED CROP PRODUCTION, PASTURE GRAZING
AL/06030005-010-01-1998	ALABAMA	STREAM/CREEK/RIVER	TENNESSEE	BIG NANCE CREEK	LAWRENCE	WILSON LAKE/CLEAR & MUDDY FORK	HIGH	ORGANIC ENRICHMENT/ DO	NONIRR CROP PROD, LANDFILLS, P GRAZING, INT. ANIMAL FEEDING OPERATIONS
ILI84_TI 01-1998	ILLINOIS	STREAM/CREEK/RIVER		MISSISSIPPI R				NUTRIENTS	IND&MUN PT S, NON-IRR CROP PROD, U RUNOFF/S SEWER, HYDRO/HAB MOD, AG

ILI01_I 98-1998	ILLINOIS	STREAM/CREEK/RIVER		MISSISSIPPI R				NUTRIENTS	IND&MUN PT S, COMB SEWER, AG NON-IRR CROP PROD, U RUNOFF/S SEWER, HYDRO/HAB MOD
ILI01_TI 05-1998	ILLINOIS	STREAM/CREEK/RIVER		MISSISSIPPI R				NUTRIENTS	IND&MUN PT S, COMB SEWER, AG NON-IRR CROP PROD, U RUNOFF/S SEWER, HYDRO/HAB MOD
ILI01_TI 06-1998	ILLINOIS	STREAM/CREEK/RIVER		MISSISSIPPI R				NUTRIENTS	IND&MUN PT S, COMB SEWER, AG NON-IRR CROP PROD, U RUNOFF/S SEWER, HYDRO/HAB MOD
ILI01_TI 08-1998	ILLINOIS	STREAM/CREEK/RIVER		MISSISSIPPI R				NUTRIENTS	IND&MUN PT S, COMB SEWER, AG NON-IRR CROP PROD, U RUNOFF/S SEWER, HYDRO/HAB MOD
ILI02_I 02-1998	ILLINOIS	STREAM/CREEK/RIVER		MISSISSIPPI R				NUTRIENTS	IND&MUNIC PT SOURCES, AG, NON-IRR CROP PROD, U RUNOF/S SEWER, HYDRO/HABITAT MOD
ILI84_I 84-1998	ILLINOIS	STREAM/CREEK/RIVER		MISSISSIPPI R				NUTRIENTS	IND&MUNIC PT SOURCES, AG, NON-IRR CROP PROD, U RUNOF/S SEWER, HYDRO/HABITAT MOD
ILI84_TI 03-1998	ILLINOIS	STREAM/CREEK/RIVER		MISSISSIPPI R				NUTRIENTS	IND&MUNIC PT SOURCES, AG, NON-IRR CROP PROD, U RUNOF/S SEWER, HYDRO/HABITAT MOD
ILI84_TI 04-1998	ILLINOIS	STREAM/CREEK/RIVER		MISSISSIPPI R				NUTRIENTS	IND&MUNIC PT SOURCES, AG, NON-IRR CROP PROD, U RUNOF/S SEWER, HYDRO/HABITAT MOD

ILI84_I 81-1998	ILLINOIS	STREAM/CREEK/RIVER		MISSISSIPPI R				NUTRIENTS	IND&MUNIC PT SOURCES, AG, NON-IRR CROP PROD, U RUNOF/S SEWER, HYDRO/HABITAT MOD
ILI01_I 01-1998	ILLINOIS	STREAM/CREEK/RIVER		MISSISSIPPI R				NUTRIENTS	IND&MUN PT S, COMB SEWER, AG NON-IRR CROP PROD, U RUNOFF/S SEWER, HYDRO/HAB MOD
ILJ03_J 96-1998	ILLINOIS	STREAM/CREEK/RIVER		MISSISSIPPI R				NUTRIENTS	IND&MUN PT S, COMB SEWER, AG NON-IRR CROP PROD, U RUNOFF/S SEWER, HYDRO/HAB MOD
ILJ03_J 03-1998	ILLINOIS	STREAM/CREEK/RIVER		MISSISSIPPI R				NUTRIENTS	IND&MUN PT S, COMB SEWER, AG NON-IRR CROP PROD, U RUNOFF/S SEWER, HYDRO/HAB MOD
ILJ03_TJ 05-1998	ILLINOIS	STREAM/CREEK/RIVER		MISSISSIPPI R				NUTRIENTS	IND&MUN PT S, COMB SEWER, AG NON-IRR CROP PROD, U RUNOFF/S SEWER, HYDRO/HAB MOD
ILJ83_J 83-1998	ILLINOIS	STREAM/CREEK/RIVER		MISSISSIPPI R				NUTRIENTS	MUNICIPAL POINT SOURCES, AGRICULTURE, NON-IRR CROP PROD, HYDRO/HABITAT MODIFICATION
ILJ81_TJ 12-1998	ILLINOIS	STREAM/CREEK/RIVER		MISSISSIPPI R				NUTRIENTS	IND&MUNIC PT SOURCES, AG, NON-IRR CROP PROD, U RUNOF/S SEWER, HYDRO/HABITAT MOD
ILJ03_TJ 06-1998	ILLINOIS	STREAM/CREEK/RIVER		MISSISSIPPI R				NUTRIENTS	IND&MUN PT S, COMB SEWER, AG NON-IRR CROP PROD, U RUNOFF/S SEWER, HYDRO/HAB MOD

ILK07_TK 06-1998	ILLINOIS	STREAM/CREEK/RIVER		MISSISSIPPI R				NUTRIENTS	AGRICULTURE, HYDROLOGIC/HABITAT MODIFICATION
ILK01_K 98-1998	ILLINOIS	STREAM/CREEK/RIVER		MISSISSIPPI R				NUTRIENTS	AGRICULTURE, HYDROLOGIC/HABITAT MODIFICATION
ILK01_TK 07-1998	ILLINOIS	STREAM/CREEK/RIVER		MISSISSIPPI R				NUTRIENTS	AGRICULTURE, HYDROLOGIC/HABITAT MODIFICATION
ILK02_TK 12-1998	ILLINOIS	STREAM/CREEK/RIVER		MISSISSIPPI R				NUTRIENTS	MUNICIPAL POINT SOURCES, AGRICULTURE, HYDROLOGIC/HABITAT MODIFICATION
ILK06_K 02-1998	ILLINOIS	STREAM/CREEK/RIVER		MISSISSIPPI R				NUTRIENTS	AGRICULTURE, HYDROLOGIC/HABITAT MODIFICATION
ILK06_TK 01-1998	ILLINOIS	STREAM/CREEK/RIVER		MISSISSIPPI R				NUTRIENTS	AGRICULTURE, HYDROLOGIC/HABITAT MODIFICATION
ILK06_TK 02-1998	ILLINOIS	STREAM/CREEK/RIVER		MISSISSIPPI R				NUTRIENTS	AGRICULTURE, HYDROLOGIC/HABITAT MODIFICATION
ILK07_K 05-1998	ILLINOIS	STREAM/CREEK/RIVER		MISSISSIPPI R				NUTRIENTS	AGRICULTURE, HYDROLOGIC/HABITAT MODIFICATION
ILK07_TK 04-1998	ILLINOIS	STREAM/CREEK/RIVER		MISSISSIPPI R				NUTRIENTS	AGRICULTURE, HYDROLOGIC/HABITAT MODIFICATION
ILK07_K 14-1998	ILLINOIS	STREAM/CREEK/RIVER		MISSISSIPPI R				NUTRIENTS	AGRICULTURE, HYDROLOGIC/HABITAT MODIFICATION
ILJ83_TJ 15-1998	ILLINOIS	STREAM/CREEK/RIVER		MISSISSIPPI R				FLOW ALTERATIONS	AGRICULTURE, HYDROLOGIC/HABITAT MODIFICATION
ILJ81_J 01-1998	ILLINOIS	STREAM/CREEK/RIVER		MISSISSIPPI R				NUTRIENTS	IND&MUN PT S, COMB SEWER, AG NON-IRR CROP PROD, U RUNOFF/S SEWER, HYDRO/HAB MOD
ILJ81_J 82-1998	ILLINOIS	STREAM/CREEK/RIVER		MISSISSIPPI R				NUTRIENTS	IND&MUNIC PT SOURCES, AG, NON-IRR CROP PROD, HYDROLOGIC/HABITAT MODIFICATION

ILJ81_J 81-1998	ILLINOIS	STREAM/CREEK/RIVER		MISSISSIPPI R				NUTRIENTS	IND&MUN PT S, COMB SEWER, AG NON-IRR CROP PROD, U RUNOFF/S SEWER, HYDRO/HAB MOD
ILJ81_TJ 17-1998	ILLINOIS	STREAM/CREEK/RIVER		MISSISSIPPI R				NUTRIENTS	IND&MUN PT S, COMB SEWER, AG NON-IRR CROP PROD, U RUNOFF/S SEWER, HYDRO/HAB MOD
ILJ83_TJ 04-1998	ILLINOIS	STREAM/CREEK/RIVER		MISSISSIPPI R				NUTRIENTS	MUNICIPAL POINT SOURCES, AGRICULTURE, NON-IRR CROP PROD, HYDRO/HABITAT MODIFICATION
ILJ83_TJ 13-1998	ILLINOIS	STREAM/CREEK/RIVER		MISSISSIPPI R				NUTRIENTS	IND&MUNIC PT SOURCES, AG, NON-IRR CROP PROD, U RUNOF/S SEWER, HYDRO/HABITAT MOD
ILK01_K 09-1998	ILLINOIS	STREAM/CREEK/RIVER		MISSISSIPPI R				NUTRIENTS	AGRICULTURE, HYDROLOGIC/HABITAT MODIFICATION
ILJ83_TJ 14-1998	ILLINOIS	STREAM/CREEK/RIVER		MISSISSIPPI R				FLOW ALTERATIONS	AGRICULTURE, HYDROLOGIC/HABITAT MODIFICATION
ILJ83_TJ 15-1998	ILLINOIS	STREAM/CREEK/RIVER		MISSISSIPPI R				NUTRIENTS	AGRICULTURE, HYDROLOGIC/HABITAT MODIFICATION
ILJ83_TJ 16-1998	ILLINOIS	STREAM/CREEK/RIVER		MISSISSIPPI R				NUTRIENTS	AGRICULTURE, HYDROLOGIC/HABITAT MODIFICATION
ILJ83_TJ 16-1998	ILLINOIS	STREAM/CREEK/RIVER		MISSISSIPPI R				FLOW ALTERATIONS	AGRICULTURE, HYDROLOGIC/HABITAT MODIFICATION
ILJ83_TJ 14-1998	ILLINOIS	STREAM/CREEK/RIVER		MISSISSIPPI R				NUTRIENTS	AGRICULTURE, HYDROLOGIC/HABITAT MODIFICATION
ILP06_P 21-1998	ILLINOIS	STREAM/CREEK/RIVER		ROCK R				FLOW ALTERATIONS	HYDROLOGIC/HABITAT MODIFICATION, FLOW REGULATION/MODIFICATION

ILP04_P 24-1998	ILLINOIS	STREAM/CREEK/RIVER		ROCK R				NUTRIENTS	AGRICULTURE, NON-IRRIGATED CROP PRODUCTION, PASTURE LAND
ILP04_P 25-1998	ILLINOIS	STREAM/CREEK/RIVER		ROCK R				NUTRIENTS	AG, NON-IRR CROP PROD, PASTURE LAND, HYDROLOGIC/HABITAT MODIFICATION, FLOW REG/MOD
ILP04_P 25-1998	ILLINOIS	STREAM/CREEK/RIVER		ROCK R				FLOW ALTERATIONS	AG, NON-IRR CROP PROD, PASTURE LAND, HYDROLOGIC/HABITAT MODIFICATION, FLOW REG/MOD
ILGI02_GI 02-1998	ILLINOIS	STREAM/CREEK/RIVER		CHIC SAN & SHIP CANAL				FLOW ALTERATIONS	IND&MUN PT SC, CSO, U RUNOFF/S SEWERS, HYDRO/HAB MOD, CHANNELIZATION, FLOW REG/MOD
ILGI02_GI 02-1998	ILLINOIS	STREAM/CREEK/RIVER		CHIC SAN & SHIP CANAL				AMMONIA	IND&MUN PT SC, CSO, U RUNOFF/S SEWERS, HYDRO/HAB MOD, CHANNELIZATION, FLOW REG/MOD
ILGI02_GI 02-1998	ILLINOIS	STREAM/CREEK/RIVER		CHIC SAN & SHIP CANAL				ORGANIC ENRICHMENT/ DO	IND&MUN PT SC, CSO, U RUNOFF/S SEWERS, HYDRO/HAB MOD, CHANNELIZATION, FLOW REG/MOD
ILGI02_GI 02-1998	ILLINOIS	STREAM/CREEK/RIVER		CHIC SAN & SHIP CANAL				NUTRIENTS	IND&MUN PT SC, CSO, U RUNOFF/S SEWERS, HYDRO/HAB MOD, CHANNELIZATION, FLOW REG/MOD
ILGI02_GI 04-1998	ILLINOIS	STREAM/CREEK/RIVER		CHIC SAN & SHIP CANAL				AMMONIA	IND&MUN PT SC, CSO, HYDRO/HAB MOD, CHANNELIZ, FLOW REG/MOD, OTHER INPLACE CONTAMIN.

ILGI02_GI 04-1998	ILLINOIS	STREAM/CREEK/RIVER		CHIC SAN & SHIP CANAL				NUTRIENTS	IND&MUN PT SC, CSO, HYDRO/HAB MOD, CHANNELIZ, FLOW REG/MOD, OTHER INPLACE CONTAMIN.
ILGI02_GI 04-1998	ILLINOIS	STREAM/CREEK/RIVER		CHIC SAN & SHIP CANAL				ORGANIC ENRICHMENT/ DO	IND&MUN PT SC, CSO, HYDRO/HAB MOD, CHANNELIZ, FLOW REG/MOD, OTHER INPLACE CONTAMIN.
ILGI02_GI 04-1998	ILLINOIS	STREAM/CREEK/RIVER		CHIC SAN & SHIP CANAL				FLOW ALTERATIONS	IND&MUN PT SC, CSO, HYDRO/HAB MOD, CHANNELIZ, FLOW REG/MOD, OTHER INPLACE CONTAMIN.
ILGI03_GI 03-1998	ILLINOIS	STREAM/CREEK/RIVER		CHIC SAN & SHIP CANAL				ORGANIC ENRICHMENT/ DO	IND&MUN PT SC, U RUNOF/S SEW, HYDRO/HAB MOD, CHANNELIZ, FL REG/MOD, INPL CONTAM, OTHR
ILGI03_GI 03-1998	ILLINOIS	STREAM/CREEK/RIVER		CHIC SAN & SHIP CANAL				AMMONIA	IND&MUN PT SC, U RUNOF/S SEW, HYDRO/HAB MOD, CHANNELIZ, FL REG/MOD, INPL CONTAM, OTHR
ILGI03_GI 03-1998	ILLINOIS	STREAM/CREEK/RIVER		CHIC SAN & SHIP CANAL				NUTRIENTS	IND&MUN PT SC, U RUNOF/S SEW, HYDRO/HAB MOD, CHANNELIZ, FL REG/MOD, INPL CONTAM, OTHR
ILGI02_GI 06-1998	ILLINOIS	STREAM/CREEK/RIVER		CHIC SAN & SHIP CANAL				AMMONIA	IND&MUN PT SC, CSO, U RUNOF/S SEWR, HYDRO/HAB MOD, CHANELIZ, FL REG/MOD, CONTAM, OTH
ILGI02_GI 06-1998	ILLINOIS	STREAM/CREEK/RIVER		CHIC SAN & SHIP CANAL				NUTRIENTS	IND&MUN PT SC, CSO, U RUNOF/S SEWR, HYDRO/HAB MOD, CHANELIZ, FL REG/MOD, CONTAM, OTH

ILGI02_GI 06-1998	ILLINOIS	STREAM/CREEK/RIVER		CHIC SAN & SHIP CANAL				ORGANIC ENRICHMENT/ DO	IND&MUN PT SC, CSO, U RUNOF/S SEWR, HYDRO/HAB MOD, CHANELIZ, FL REG/MOD, CONTAM, OTH
ILGI02_GI 06-1998	ILLINOIS	STREAM/CREEK/RIVER		CHIC SAN & SHIP CANAL				FLOW ALTERATIONS	IND&MUN PT SC, CSO, U RUNOF/S SEWR, HYDRO/HAB MOD, CHANELIZ, FL REG/MOD, CONTAM, OTH
ILGI02_GI 05-1998	ILLINOIS	STREAM/CREEK/RIVER		CHIC SAN & SHIP CANAL				ORGANIC ENRICHMENT/ DO	IND&MUN PT SC, CSO, U RUNOF/S SEWR, HYDRO/HAB MOD, CHANELIZ, FL REG/MOD, CONTAM, OTH
ILGI02_GI 05-1998	ILLINOIS	STREAM/CREEK/RIVER		CHIC SAN & SHIP CANAL				NUTRIENTS	IND&MUN PT SC, CSO, U RUNOF/S SEWR, HYDRO/HAB MOD, CHANELIZ, FL REG/MOD, CONTAM, OTH
ILGI02_GI 05-1998	ILLINOIS	STREAM/CREEK/RIVER		CHIC SAN & SHIP CANAL				AMMONIA	IND&MUN PT SC, CSO, U RUNOF/S SEWR, HYDRO/HAB MOD, CHANELIZ, FL REG/MOD, CONTAM, OTH
ILGI02_GI 05-1998	ILLINOIS	STREAM/CREEK/RIVER		CHIC SAN & SHIP CANAL				FLOW ALTERATIONS	IND&MUN PT SC, CSO, U RUNOF/S SEWR, HYDRO/HAB MOD, CHANELIZ, FL REG/MOD, CONTAM, OTH
ILCH01_CH 11-1998	ILLINOIS	STREAM/CREEK/RIVER		FOX R				ORGANIC ENRICHMENT/ DO	AG, NON-IRR CROP PROD, RESOURCE EXTRACTION, PETROLEUM ACTIVITIES
ILCH01_CH 11-1998	ILLINOIS	STREAM/CREEK/RIVER		FOX R				NUTRIENTS	AG, NON-IRR CROP PROD, RESOURCE EXTRACTION, PETROLEUM ACTIVITIES

ILRTF-1998	ILLINOIS	LAKE/RESERVOIR/POND		FOX				NUTRIENTS	AG, NON-IRR C PRD, CONST, L DEV, U RUNOF/SS, L DISP, WSTEWTR SYS, HYDRO/HAB MOD, DRDG
IA 03-SKM-0010_1998	IOWA	STREAM/CREEK/RIVER		MISSISSIPIPI RIVER		EPA ADDED WATER		AMMONIA	UNKNOWN
IA 03-SKM-0010-1_1998	IOWA	STREAM/CREEK/RIVER		MISSISSIPPI RIVER	UPRIVER FROM KEOKUK TO SKUNK RIVER	Further study needed to identify sources.	LOW	AMMONIA-NITROGEN	
IA 03-SKM-0010-1(B)_1998	IOWA	STREAM/CREEK/RIVER		MISSISSIPPI R		EPA ADDED WATER		AMMONIA-NITROGEN	
IA 01-WPS-0010(B)_1998	IOWA	STREAM/CREEK/RIVER		WAPSIPINICON RIVER, PARK VIEW		EPA ADDED WATER		AMMONIA	
IA 01-WPS-0010(A)_1998	IOWA	STREAM/CREEK/RIVER		WAPSIPINICON RIVER, LONG GROVE		EPA ADDED WATER		AMMONIA	
IA 02-IOW-0060_1998	IOWA	STREAM/CREEK/RIVER		IOWA RIVER, MARSHALLTOWN		EPA ADDED WATER		AMMONIA	
IA 02-IOW-0050(B)_1998	IOWA	STREAM/CREEK/RIVER		IOWA RIVER		EPA ADDED WATER		AMMONIA	
IA 02-IOW-0030(B)_1998	IOWA	STREAM/CREEK/RIVER		IOWA RIVER, MODERN MANOR		EPA ADDED WATER		AMMONIA	
IA 02-CED-0010(A)_1998	IOWA	STREAM/CREEK/RIVER		CEDAR RIVER, CEDAR FALLS		EPA ADDED WATER		AMMONIA	
IA 02-CED-0010(B)_1998	IOWA	STREAM/CREEK/RIVER		CEDAR RIVER, CEDAR FALLS		EPA ADDED WATER		AMMONIA	
IA 02-CED-0010(C)_1998	IOWA	STREAM/CREEK/RIVER		CEDAR RIVER, LA PORTE		EPA ADDED WATER		AMMONIA	
IA 02-CED-0010(C)_1998	IOWA	STREAM/CREEK/RIVER						AMMONIA	
KY21012101-1998	KENTUCKY	Lake/Reservoir/Pond	KENTUCKY RIVER	HERRINGTON LAKE	GARRARD, BOYLE, MERCER CO		IN PROGRESS	ORGANIC ENRICHMENT/ LOW DISSOLVED OXYGEN	
KY21016024-1998	KENTUCKY	Stream/Creek/River	LOWER CUMBERLAND	LITTLE RIVER	TRIGG CO		FIRST PRIORITY	NUTRIENTS	
MN-07040006-002-a-1998	MINNESOTA	STREAM/CREEK/RIVER	UPPER MISSISSIPPI RIVER BASIN, LOWER PORTION	MISSISSIPPI RIVER	LA CROSSE R. TO ROOT R.			AMMONIA	
MN-07010104-226-1998	MINNESOTA	STREAM/CREEK/RIVER	UPPER MISSISSIPPI RIVER BASIN, UPPER PORTION	MISSISSIPPI RIVER	PINE R. TO BRAINERD DAM			LOW OXYGEN	

MN-07010103-131-1998	MINNESOTA	STREAM/CREEK/RIVER	UPPER MISSISSIPPI RIVER BASIN, UPPER PORTION	MISSISSIPPI RIVER	GRAND RAPIDS DAM TO PRAIRIE R.			LOW OXYGEN	
MO-7205-1998	MISSOURI	LAKE/RESERVOIR/POND	LOWER MISSOURI	MISSOURI RIVER	TRUMAN DAM			LOW DO GASEOUS SUPERSATURATION	
MO-7514-1998	MISSOURI	LAKE/RESERVOIR/POND	LOWER MISSOURI	MISSOURI RIVER	TABLE ROCK DAM			LOW DO	
MS192IE-1998	MISSISSIPPI		TENNESSEE	INDIAN CREEK- DA	DRAINAGE AREA NEAR IUKA			NUTRIENTS	
MS192IE-1998	MISSISSIPPI		TENNESSEE	INDIAN CREEK- DA	DRAINAGE AREA NEAR IUKA			ORGANIC ENRICHMENT/ LOW DO	
MS193YE-1998	MISSISSIPPI		TENNESSEE	YELLOW CREEK- DA	DRAINAGE AREA NEAR DOSKIE			NUTRIENTS	
MS194E-1998	MISSISSIPPI		TENNESSEE	BEAR CREEK- DA	DRAINAGE AREA NEAR BURNSTOWN			ORGANIC ENRICHMENT/ LOW DO	
MT43P0051-1998	MONTANA	Stream/Creek/River		BIGHORN R			LOW	ORGANIC ENRICHMENT/ LOW DISSOLVED OXYGEN	UPSTREAM IMPOUNDMENT, AGRICULTURE, FLOW REGULATION/MODIFICATION, NATURAL SOURCES
MT43P0051-1998	MONTANA	Stream/Creek/River		BIGHORN R			LOW	THERMAL MODIFICATIONS	UPSTREAM IMPOUNDMENT, AGRICULTURE, FLOW REGULATION/MODIFICATION, NATURAL SOURCES
MT43P0051-1998	MONTANA	Stream/Creek/River		BIGHORN R			LOW	FLOW ALTERATION	UPSTREAM IMPOUNDMENT, AGRICULTURE, FLOW REGULATION/MODIFICATION, NATURAL SOURCES
MT40E0011-1998	MONTANA	Lake/Reservoir/Pond		FORT PECK RESERVOIR	1		LOW	FLOW ALTERATIONS	AGRI, FLOW REG/MOD,IRR CROP PROD, NATURAL SOURCES, RANGE LAND

MT40E0011-1998	MONTANA	Lake/Reservoir/Pond		FORT PECK RESERVOIR	1		LOW	NUTRIENTS	AGRI, FLOW REG/MOD,IRR CROP PROD, NATURAL SOURCES, RANGE LAND
MT40E0011-1998	MONTANA	Lake/Reservoir/Pond		FORT PECK RESERVOIR	1		LOW	ORGANIC ENRICHMENT/ LOW DISSOLVED OXYGEN	AGRI, FLOW REG/MOD,IRR CROP PROD, NATURAL SOURCES, RANGE LAND
MT41Q0011-1998	MONTANA	Stream/Creek/River		MISSOURI R	1		LOW	FLOW ALTERATION	UPSTRM IMPOUNDMNT, AG, IRR CROP PROD, NAT SOURCES, R LAND, STRMBANK MOD/DESTABILIZ
MT41Q0011-1998	MONTANA	Stream/Creek/River		MISSOURI R	1		LOW	NUTRIENTS	UPSTRM IMPOUNDMNT, AG, IRR CROP PROD, NAT SOURCES, R LAND, STRMBANK MOD/DESTABILIZ
MT41I0031-1998	MONTANA	Lake/Reservoir/Pond		CANYON FERRY RESERVOIR			LOW	NUTRIENTS	AGRICULTURE, LAND DEVELOPMENT
MT41I00071-1998	MONTANA	Lake/Reservoir/Pond		HOLTER LAKE			LOW	NUTRIENTS	AGRICULTURE, LAND DEVELOPMENT
NE-BB1-10000-1998	NEBRASKA	STREAM/CREEK/RIVER		BIG BLUE RIVER		TMDL Partially Completed1	LOW	AMMONIA (UN-IONIZED)	INDUSTRIAL POINT SOURCE
NE-BB1-10000-1998	NEBRASKA	STREAM/CREEK/RIVER		BIG BLUE RIVER		TMDL Partially Completed1	LOW	AMMONIA (UN-IONIZED)	MUNICIPAL POINT SOURCE
OH37 25-101-1998	OHIO	LAKE/RESERVOIR/POND	SCIOTO RIVER	O'SHAUGHNESSY RESERVOIR		ME		NUTRIENTS	IND&MUNIC PT SOURCES, NON&IRR CROP PROD, R&P LAND, FEEDLOTS, LAND DEVE, URBANIZATION
OH37 19-132-1998	OHIO	LAKE/RESERVOIR/POND	SCIOTO RIVER	J. GRIGGS RESERVOIR		ME		ORGANIC ENRICHMENT/ DO	HYDROMODIFICATION, AGRICULTURE
OH37 19-132-1998	OHIO	LAKE/RESERVOIR/POND	SCIOTO RIVER	J. GRIGGS RESERVOIR		ME		NUTRIENTS	HYDROMODIFICATION, AGRICULTURE

OH38 20-1998	OHIO	STREAM/CREEK/RIVER	SCIOTO RIVER	BIG WALNUT CREEK (HOOVER RES. DAM TO ROCKY FORK)		M		FLOW ALTERATION	UPSTREAM IMPOUNDMENT, FLOW REGULATION/MODIFICATION
OH38 20-1998	OHIO	STREAM/CREEK/RIVER	SCIOTO RIVER	BIG WALNUT CREEK (HOOVER RES. DAM TO ROCKY FORK)		M		THERMAL MODIFICATION	UPSTREAM IMPOUNDMENT, FLOW REGULATION/MODIFICATION
OH41 39-299-1998	OHIO	LAKE/RESERVOIR/POND	SCIOTO RIVER	HARGUS LAKE		ME		FLOW ALTERATION	COMB SEWR OVR, ONSITE WST SYS, CONTAM SED, NON&IRR C PROD, P LAND, FDLOTS, URB RNOF
OH41 39-299-1998	OHIO	LAKE/RESERVOIR/POND	SCIOTO RIVER	HARGUS LAKE		ME		AMMONIA	COMB SEWR OVR, ONSITE WST SYS, CONTAM SED, NON&IRR C PROD, P LAND, FDLOTS, URB RNOF
OH41 39-299-1998	OHIO	LAKE/RESERVOIR/POND	SCIOTO RIVER	HARGUS LAKE		ME		ORGANIC ENRICHMENT/DO	COMB SEWR OVR, ONSITE WST SYS, CONTAM SED, NON&IRR C PROD, P LAND, FDLOTS, URB RNOF
OH41 39-299-1998	OHIO	LAKE/RESERVOIR/POND	SCIOTO RIVER	HARGUS LAKE		ME		NUTRIENTS	COMB SEWR OVR, ONSITE WST SYS, CONTAM SED, NON&IRR C PROD, P LAND, FDLOTS, URB RNOF
OH41 39-1998	OHIO	STREAM/CREEK/RIVER	SCIOTO RIVER	HARGUS CREEK		M		ORGANIC ENRICHMENT/DO	MUNIC PT SOURCES, URB RUNOFF/S SEWER, ONSITE WASTE SYSTEMS, HYDROMODIFICATIONS
OH41 15-298-1998	OHIO	LAKE/RESERVOIR/POND	SCIOTO RIVER	DEER CREEK LAKE		ME		ORGANIC ENRICHMENT/DO	AGRICULTURE
OH41 15-298-1998	OHIO	LAKE/RESERVOIR/POND	SCIOTO RIVER	DEER CREEK LAKE		ME		NUTRIENTS	AGRICULTURE
OH41 15-298-1998	OHIO	LAKE/RESERVOIR/POND	SCIOTO RIVER	DEER CREEK LAKE		ME		AMMONIA	AGRICULTURE

OH43 49-187-1998	OHIO	LAKE/RESERVOIR/POND	SCIOTO RIVER	HILLSBORO RESERVOIR		ME		ORGANIC ENRICHMENT/DO	AGRICULTURE, INDUSTRIAL POINT SOURCES, ONSITE WASTEWATER SYSTEMS, NATURAL
OH43 44-185-1998	OHIO	LAKE/RESERVOIR/POND	SCIOTO RIVER	ROCKY FORK LAKE		ME		NUTRIENTS	MUNIC & INDUST PT SOURCES, NON-IRR CROP PROD, ONSITE WASTEWATER SYSTEMS, NATURAL
OH42 1-186-1998	OHIO	LAKE/RESERVOIR/POND	SCIOTO RIVER	PAINT CREEK LAKE		ME		ORGANIC ENRICHMENT/DO	MUNICIPAL & INDUSTRIAL POINT SOURCES, NON-IRRIGATED CROP PRODUCTION
OH42 1-186-1998	OHIO	LAKE/RESERVOIR/POND	SCIOTO RIVER	PAINT CREEK LAKE		ME		NUTRIENTS	MUNICIPAL & INDUSTRIAL POINT SOURCES, NON-IRRIGATED CROP PRODUCTION
OH41 30-228-1998	OHIO	LAKE/RESERVOIR/POND	SCIOTO RIVER	MADISON LAKE		ME		ORGANIC ENRICHMENT/DO	AG, PASTURE & RANGE LAND, NON-IRRIGATED CROP PROD, FEEDLOTS, NATURAL
OH41 30-228-1998	OHIO	LAKE/RESERVOIR/POND	SCIOTO RIVER	MADISON LAKE		ME		NUTRIENTS	AG, PASTURE & RANGE LAND, NON-IRRIGATED CROP PROD, FEEDLOTS, NATURAL
OK621210000010-1998	OKLAHOMA			ARKANSAS RIVER			4	NUTRIENTS	AGRICULTURE, URBAN RUNOFF
OK621210000020-1998	OKLAHOMA			KAW LAKE (ARKANSAS RIVER)			4	ORGANIC ENRICHMENT/DO	PASTURE LAND, RANGE LAND, PETROLEUM ACTIVITIES
OK621210000020-1998	OKLAHOMA			KAW LAKE (ARKANSAS RIVER)			4	NUTRIENTS	PASTURE LAND, RANGE LAND, PETROLEUM ACTIVITIES
OK621210000030-1998	OKLAHOMA			ARKANSAS RIVER			3	NUTRIENTS	HIGHWAY MAINTENANCE AND RUNOFF

OK621210000030-1998	OKLAHOMA			ARKANSAS RIVER			3	ORGANIC ENRICHMENT/ DO	HIGHWAY MAINTENANCE AND RUNOFF
OK621210000040-1998	OKLAHOMA			KAW LAKE, ARKANSAS RIVER ARM		Oilfield pollution no longer a known problem	4	NUTRIENTS	P LAND, R LAND, FLOW REG/MOD, NON-IRR CROP PROD, HWY MAINT/RUNOFF
OK621210000040-1998	OKLAHOMA			KAW LAKE, ARKANSAS RIVER ARM		Oilfield pollution no longer a known problem	4	ORGANIC ENRICHMENT/ DO	P LAND, R LAND, FLOW REG/MOD, NON-IRR CROP PROD, HWY MAINT/RUNOFF
OK621210000040-1998	OKLAHOMA			KAW LAKE, ARKANSAS RIVER ARM		Oilfield pollution no longer a known problem	4	THERMAL STRATIFICATI ON	P LAND, R LAND, FLOW REG/MOD, NON-IRR CROP PROD, HWY MAINT/RUNOFF
OK621210000040-1998	OKLAHOMA			KAW LAKE, ARKANSAS RIVER ARM		Oilfield pollution no longer a known problem	4	FLOW ALTERATION	P LAND, R LAND, FLOW REG/MOD, NON-IRR CROP PROD, HWY MAINT/RUNOFF
OK621210000060-1998	OKLAHOMA			KAW LAKE, BEAVER CREEK ARM		Oilfield pollution no longer a known problem	4	NUTRIENTS	P LAND, R LAND, FLOW REG/MOD, NON-IRR CROP PROD, HWY MAINT/RUNOFF
OK621210000060-1998	OKLAHOMA			KAW LAKE, BEAVER CREEK ARM		Oilfield pollution no longer a known problem	4	THERMAL STRATIFICATI ON	P LAND, R LAND, FLOW REG/MOD, NON-IRR CROP PROD, HWY MAINT/RUNOFF
OK621210000060-1998	OKLAHOMA			KAW LAKE, BEAVER CREEK ARM		Oilfield pollution no longer a known problem	4	ORGANIC ENRICHMENT/ DO	P LAND, R LAND, FLOW REG/MOD, NON-IRR CROP PROD, HWY MAINT/RUNOFF
OK621210000060-1998	OKLAHOMA			KAW LAKE, BEAVER CREEK ARM		Oilfield pollution no longer a known problem	4	FLOW ALTERATION	P LAND, R LAND, FLOW REG/MOD, NON-IRR CROP PROD, HWY MAINT/RUNOFF
OK621200010010-1998	OKLAHOMA			ARKANSAS RIVER			2	NUTRIENTS	SOURCE UNKNOWN

OK621200010020-1998	OKLAHOMA			KEYSTONE LAKE		Oilfield pollution no longer a known problem	3	FLOW ALTERATION	P & R LAND, FLOW REG/MOD, NON-IRR & IRR CROP PROD, HWY MAINT/RUNOFF, IN-PLACE CONTAM
OK621200010020-1998	OKLAHOMA			KEYSTONE LAKE		Oilfield pollution no longer a known problem	3	THERMAL STRATIFICATI ON	P & R LAND, FLOW REG/MOD, NON-IRR & IRR CROP PROD, HWY MAINT/RUNOFF, IN-PLACE CONTAM
OK621200010020-1998	OKLAHOMA			KEYSTONE LAKE		Oilfield pollution no longer a known problem	3	ORGANIC ENRICHMENT/ DO	P & R LAND, FLOW REG/MOD, NON-IRR & IRR CROP PROD, HWY MAINT/RUNOFF, IN-PLACE CONTAM
OK621200010020-1998	OKLAHOMA			KEYSTONE LAKE		Oilfield pollution no longer a known problem	3	NUTRIENTS	P & R LAND, FLOW REG/MOD, NON-IRR & IRR CROP PROD, HWY MAINT/RUNOFF, IN-PLACE CONTAM
OK621200010050-1998	OKLAHOMA			KEYSTONE LAKE, ARKANSAS			3	FLOW ALTERATION	SAME AS ABOVE PLUS PETROLEUM ACTIVITIES
OK621200010050-1998	OKLAHOMA			KEYSTONE LAKE, ARKANSAS			3	ORGANIC ENRICHMENT/ DO	SAME AS ABOVE PLUS PETROLEUM ACTIVITIES
OK621200010050-1998	OKLAHOMA			KEYSTONE LAKE, ARKANSAS			3	THERMAL STRATIFICATI ON	SAME AS ABOVE PLUS PETROLEUM ACTIVITIES
OK621200010050-1998	OKLAHOMA			KEYSTONE LAKE, ARKANSAS			3	NUTRIENTS	SAME AS ABOVE PLUS PETROLEUM ACTIVITIES
OK620900010090-1998	OKLAHOMA			KEYSTONE LAKE, CIMARRON		Oilfield pollution no longer a known problem	3	ORGANIC ENRICHMENT/ DO	P&R LAND, NONIRR & IRR CRP PROD, FL REG/MOD, HWY MAINT/RNOF, CHNLIZA, REM RIP VEG, NAT
OK620900010090-1998	OKLAHOMA			KEYSTONE LAKE, CIMARRON		Oilfield pollution no longer a known problem	3	THERMAL STRATIFICATI ON	P&R LAND, NONIRR & IRR CRP PROD, FL REG/MOD, HWY MAINT/RNOF, CHNLIZA, REM RIP VEG, NAT

OK621200010040-1998	OKLAHOMA			ARKANSAS RIVER			2	NUTRIENTS	AG, HWY MAINT/RUNOFF, IN-PLACE CONTAMINANTS, NATURAL
OK621200010200-1998	OKLAHOMA			ARKANSAS RIVER		Oilfield pollution no longer a known problem	2	NUTRIENTS	NON-IRR & IRR CROP PROD, NATURAL
OK621200020010-1998	OKLAHOMA			ARKANSAS RIVER		Oilfield pollution no longer a known problem	2	NUTRIENTS	PASTURE LAND, RANGE LAND, REMOVAL OF RIPARIAN VEGETATION
OK120400010010-1998	OKLAHOMA			ARKANSAS RIVER		Muskogee, Ft. Howard & OG&E are located in this segment	1	ORGANIC ENRICHMENT/ DO	P & R LAND, FEEDLOTS- ALL TYPES, LAND DISPOSAL
OK120400010010-1998	OKLAHOMA			ARKANSAS RIVER		Muskogee, Ft. Howard & OG&E are located in this segment	1	NUTRIENTS	P & R LAND, FEEDLOTS- ALL TYPES, LAND DISPOSAL
OK120400010060-1998	OKLAHOMA			ARKANSAS RIVER		Muskogee, Ft. Howard & OG&E are located in this segment	1	ORGANIC ENRICHMENT/ DO	P & R LAND, FEEDLOTS- ALL TYPES, LAND DISPOSAL
OK120400010060-1998	OKLAHOMA			ARKANSAS RIVER		Muskogee, Ft. Howard & OG&E are located in this segment	1	NUTRIENTS	P & R LAND, FEEDLOTS- ALL TYPES, LAND DISPOSAL
OK220200010010-1998	OKLAHOMA			ARKANSAS RIVER			3	ORGANIC ENRICHMENT/ DO	SOURCE UNKNOWN
OK220200020010-1998	OKLAHOMA			ARKANSAS RIVER			2	ORGANIC ENRICHMENT/ DO	DAM CONSTR, P&R LAND, FEEDLOTS, NON-IRR CROP PROD, SURFACE MINING, STORM SEWERS
OK121700030350-1998	OKLAHOMA			ILLINOIS RIVER		Priority raised. Included in Illinois River project	1	NUTRIENTS	DAM CONSTR, P&R LAND, FEEDLOTS, NON-IRR CROP PROD, NPS, FLOW REG/MOD, LAND DEVELOP

OK121700020210-1998	OKLAHOMA			ILLINOIS RIVER		Included in Illinois River project. Cause code 1100 added 1998 per OSRC input.	1	FLOW ALTERATION	NONPOINT SOURCE, FLOW REGULATION/MODIFICATION
OK121700020210-1998	OKLAHOMA			ILLINOIS RIVER		Included in Illinois River project. Cause code 1100 added 1998 per OSRC input.	1	ORGANIC ENRICHMENT/DO	NONPOINT SOURCE, FLOW REGULATION/MODIFICATION
OK121700010010-1998	OKLAHOMA			ILLINOIS RIVER		Priority lowered. Segment below Lake Tenkiller	2	FLOW ALTERATION	NONPOINT SOURCE, FLOW REGULATION/MODIFICATION
OK121700010010-1998	OKLAHOMA			ILLINOIS RIVER		Priority lowered. Segment below Lake Tenkiller	2	ORGANIC ENRICHMENT/DO	NONPOINT SOURCE, FLOW REGULATION/MODIFICATION
OK121700020010-1998	OKLAHOMA			ILLINOIS RIVER		Included in Illinois River project. Cause code 1100 added 1998 per OSRC input.	1	ORGANIC ENRICHMENT/DO	NONPOINT SOURCE, FLOW REGULATION/MODIFICATION
OK121700020010-1998	OKLAHOMA			ILLINOIS RIVER		Included in Illinois River project. Cause code 1100 added 1998 per OSRC input.	1	FLOW ALTERATION	NONPOINT SOURCE, FLOW REGULATION/MODIFICATION
OK121700020020-1998	OKLAHOMA			TENKILLER FERRY LAKE		Priority raised. Included in Illinois River project	1	NUTRIENTS	AGRICULTURE, FLOW REGULATION/MODIFICATION
OK121700020020-1998	OKLAHOMA			TENKILLER FERRY LAKE		Priority raised. Included in Illinois River project	1	FLOW ALTERATION	AGRICULTURE, FLOW REGULATION/MODIFICATION
OK121700020300-1998	OKLAHOMA			ILLINOIS RIVER		Priority raised. Included in Illinois River project	1	ORGANIC ENRICHMENT/DO	P&R LAND, FDLOTS, FLO REG/MOD, NONIRR C PROD, LAND DEVE, ANIMAL HOLD/MGMT, HWY BRDGE

OK121700020300-1998	OKLAHOMA			ILLINOIS RIVER		Priority raised. Included in Illinois River project	1	NUTRIENTS	P&R LAND, FDLOTS, FLO REG/MOD, NONIRR C PROD, LAND DEVE, ANIMAL HOLD/MGMT, HWY BRDGE
OK121700030010-1998	OKLAHOMA			ILLINOIS RIVER		Priority raised. Included in Illinois River project	1	ORGANIC ENRICHMENT/ DO	P&R LAND, FDLOTS, FLO REG/MOD, NONIRR C PROD, LAND DEVE, ANIMAL HOLD/MGMT, HWY BRDGE
OK121700030010-1998	OKLAHOMA			ILLINOIS RIVER		Priority raised. Included in Illinois River project	1	NUTRIENTS	P&R LAND, FDLOTS, FLO REG/MOD, NONIRR C PROD, LAND DEVE, ANIMAL HOLD/MGMT, HWY BRDGE
OK121700030080-1998	OKLAHOMA			ILLINOIS RIVER		Priority raised. Included in Illinois River project	1	NUTRIENTS	P&R LAND, FDLOTS, FLO REG/MOD, NONIRR C PROD, LAND DEVE, ANIMAL HOLD/MGMT, HWY BRDGE
OK121700030080-1998	OKLAHOMA			ILLINOIS RIVER		Priority raised. Included in Illinois River project	1	ORGANIC ENRICHMENT/ DO	P&R LAND, FDLOTS, FLO REG/MOD, NONIRR C PROD, LAND DEVE, ANIMAL HOLD/MGMT, HWY BRDGE
OK121700030280-1998	OKLAHOMA			ILLINOIS RIVER		Priority raised. Included in Illinois River project	1	NUTRIENTS	P&R LAND, FDLOTS, FLO REG/MOD, NONIRR C PROD, LAND DEVE, ANIMAL HOLD/MGMT, HWY BRDGE

OK121700030280-1998	OKLAHOMA			ILLINOIS RIVER		Priority raised. Included in Illinois River project	1	ORGANIC ENRICHMENT/ DO	P&R LAND, FDLOTS, FLO REG/MOD, NONIRR C PROD, LAND DEVE, ANIMAL HOLD/MGMT, HWY BRDGE
OK121700020020-1998	OKLAHOMA			TENKILLER FERRY LAKE		Priority raised. Included in Illinois River project	1	ORGANIC ENRICHMENT/ DO	AGRICULTURE, FLOW REGULATION/MODIFI CATION
OK121600030050-1998	OKLAHOMA			NEOSHO (GRAND) RIVER		Included in Grand Lake project. Potential Neosho madtom, Winged mapleleaf habitat.	1	NUTRIENTS	P LAND, NON-IRR CROP PROD, FEEDLOTS, ON-SITE WSTWATER SYSTEMS, REC ACTIVITIES
OK121600030280-1998	OKLAHOMA			LAKE O' THE CHEROKEES, MIDDLE		Priority raised. Included in Grand Lake project. Potential Ozark cavefish habitat.	1	NUTRIENTS	AG, P&R LAND, NONIRR C PROD, FDLOTS, CONST, URB RUNOF, RES EXTR/EXPLOR/DEV, CONTAM
OK121600030280-1998	OKLAHOMA			LAKE O' THE CHEROKEES, MIDDLE		Priority raised. Included in Grand Lake project. Potential Ozark cavefish habitat.	1	AMMONIA	AG, P&R LAND, NONIRR C PROD, FDLOTS, CONST, URB RUNOF, RES EXTR/EXPLOR/DEV, CONTAM
OK121600030270-1998	OKLAHOMA			NEOSHO (GRAND) RIVER		Included in Grand Lake project. Potential Neosho madtom, Winged mapleleaf habitat.	1	AMMONIA	P&R LAND, FEEDLOTS, NON-IRR CROP PROD, ANIMAL HOLDING/MGMT, SOURCE UNKNOWN
OK121600030270-1998	OKLAHOMA			NEOSHO (GRAND) RIVER		Included in Grand Lake project. Potential Neosho madtom, Winged mapleleaf habitat.	1	NUTRIENTS	P&R LAND, FEEDLOTS, NON-IRR CROP PROD, ANIMAL HOLDING/MGMT, SOURCE UNKNOWN

OK121600030270-1998	OKLAHOMA			NEOSHO (GRAND) RIVER		Included in Grand Lake project. Potential Neosho madtom, Winged mapleleaf habitat.	1	ORGANIC ENRICHMENT/ DO	P&R LAND, FEEDLOTS, NON-IRR CROP PROD, ANIMAL HOLDING/MGMT, SOURCE UNKNOWN
OK121600030290-1998	OKLAHOMA			LAKE O' THE CHEROKEES, HONEY CREEK		Priority raised. Included in Grand Lake project. Source code 6200 (Simmons Industries) and cause code 2200 added 1998 per AG input. Potential Ozark cavefish habitat.	1	NUTRIENTS	P&R LAND, FEEDLOTS, NON-IRR CROP PROD, ANIMAL HOLDING/MGMT, SOURCE UNKNOWN
OK121600030290-1998	OKLAHOMA			LAKE O' THE CHEROKEES, HONEY CREEK		Priority raised. Included in Grand Lake project. Source code 6200 (Simmons Industries) and cause code 2200 added 1998 per AG input. Potential Ozark cavefish habitat.	1	AMMONIA	P&R LAND, FEEDLOTS, NON-IRR CROP PROD, ANIMAL HOLDING/MGMT, SOURCE UNKNOWN
OK121600030150-1998	OKLAHOMA			LAKE O' THE CHEROKEES, LOWER MIDDLE		Priority raised. Included in Grand Lake project. Potential Ozark cavefish habitat.	1	NUTRIENTS	AG, P&R LAND, NONIRR C PROD, FDLOTS, CONST, URB RUNOF, RES EXTR/EXPLOR/DEV, CONTAM
OK121600030150-1998	OKLAHOMA			LAKE O' THE CHEROKEES, LOWER MIDDLE		Priority raised. Included in Grand Lake project. Potential Ozark cavefish habitat.	1	ORGANIC ENRICHMENT/ DO	AG, P&R LAND, NONIRR C PROD, FDLOTS, CONST, URB RUNOF, RES EXTR/EXPLOR/DEV, CONTAM

OK121600030140-1998	OKLAHOMA			NEOSHO (GRAND) RIVER		Included in Grand Lake project. Potential Neosho madtom, Winged mapleleaf habitat.	1	NUTRIENTS	P LAND, NON-IRR CROP PROD, FEEDLOTS, ON-SITE WASTEWATER SYSTEMS, REC ACTIVITIES
OK121600030140-1998	OKLAHOMA			NEOSHO (GRAND) RIVER		Included in Grand Lake project. Potential Neosho madtom, Winged mapleleaf habitat.	1	ORGANIC ENRICHMENT/ DO	P LAND, NON-IRR CROP PROD, FEEDLOTS, ON-SITE WASTEWATER SYSTEMS, REC ACTIVITIES
OK121600030060-1998	OKLAHOMA			LAKE O' THE CHEROKEES (GRAND)		Priority raised. Included in Grand Lake project. Potential Ozark cavefish habitat.	1	NUTRIENTS	AG, P LAND, NONIRR CROP, FDLOTS, CONST, R RUNOFF, RES EXTR/EXPLOR/DEVE, CONTAMIN, REC
OK121600030060-1998	OKLAHOMA			LAKE O' THE CHEROKEES (GRAND)		Priority raised. Included in Grand Lake project. Potential Ozark cavefish habitat.	1	ORGANIC ENRICHMENT/ DO	AG, P LAND, NONIRR CROP, FDLOTS, CONST, R RUNOFF, RES EXTR/EXPLOR/DEVE, CONTAMIN, REC
OK121600040010-1998	OKLAHOMA			NEOSHO (GRAND) RIVER		Potential Neosho madtom, Winged mapleleaf habitat.	1	ORGANIC ENRICHMENT/ DO	P&R LAND, NON-IRR CROP PROD, IN-PLACEMENT CONTAMINANTS
OK121600030370-1998	OKLAHOMA			NEOSHO (GRAND) RIVER		Included in Grand Lake project. Potential Neosho madtom, Winged mapleleaf habitat.	1	NUTRIENTS	P&R LAND, NON-IRR CROP PROD, IN-PLACEMENT CONTAMINANTS

OK121600030290-1998	OKLAHOMA			LAKE O' THE CHEROKEES, HONEY CREEK		Priority raised. Included in Grand Lake project. Source code 6200 (Simmons Industries) and cause code 2200 added 1998 per AG input. Potential Ozark cavefish habitat.	1	ORGANIC ENRICHMENT/ DO	P & R LAND, FDLOTS, NON-IRR CROP PROD, ANIMAL HOLD/MGMT, L DISPOSAL, SOURCE UNKNOWN
OK121600030020-1998	OKLAHOMA			LAKE O' THE CHEROKEES (GRAND)		Priority raised. Included in Grand Lake project. Potential Ozark cavefish habitat.	1	NUTRIENTS	AG, P LAND, NONIRR CROP, FDLOTS, CONST, R RUNOFF, RES EXTR/EXPLOR/DEVE, CONTAMIN, REC
OK121600030370-1998	OKLAHOMA			NEOSHO (GRAND) RIVER		Included in Grand Lake project. Potential Neosho madtom, Winged mapleleaf habitat.	1	ORGANIC ENRICHMENT/ DO	P&R LAND, NON-IRR CROP PROD, IN-PLACEMENT CONTAMINANTS
OK121600030050-1998	OKLAHOMA			NEOSHO (GRAND) RIVER		Included in Grand Lake project. Potential Neosho madtom, Winged mapleleaf habitat.	1	ORGANIC ENRICHMENT/ DO	P LAND, NON-IRR CROP PROD, FEEDLOTS, ON-SITE WASTEWATER SYSTEMS, REC ACTIVITIES
OK121600030020-1998	OKLAHOMA			LAKE O' THE CHEROKEES (GRAND)		Priority raised. Included in Grand Lake project. Potential Ozark cavefish habitat.	1	ORGANIC ENRICHMENT/ DO	AG, P LAND, NONIRR CROP, FDLOTS, CONST, R RUNOFF, RES EXTR/EXPLOR/DEVE, CONTAMIN, REC
OK121600030010-1998	OKLAHOMA			NEOSHO (GRAND) RIVER		Included in Grand Lake project. Potential Neosho madtom, Winged mapleleaf habitat.	1	ORGANIC ENRICHMENT/ DO	P LAND, NON-IRR CROP PROD, FEEDLOTS, ON-SITE WASTEWATER SYSTEMS, REC ACTIVITIES

OK121600030010-1998	OKLAHOMA			NEOSHO (GRAND) RIVER		Included in Grand Lake project. Potential Neosho madtom, Winged mapleleaf habitat.	1	NUTRIENTS	P LAND, NON-IRR CROP PROD, FEEDLOTS, ON-SITE WASTEWATER SYSTEMS, REC ACTIVITIES	
OK121600020170-1998	OKLAHOMA			NEOSHO (GRAND) RIVER		Priority lowered. Located in Hudson Lake segment, not Grand Lake	4	ORGANIC ENRICHMENT/ DO	FLOW REGULATION/MODIFICATION	
OK121600020010-1998	OKLAHOMA			NEOSHO (GRAND) RIVER		Priority lowered. Located in Hudson Lake segment, not Grand Lake	4	ORGANIC ENRICHMENT/ DO	SURFACE MINING, IN-PLACEMENT CONTAMINANTS	
OK121600010280-1998	OKLAHOMA			NEOSHO (GRAND) RIVER		Priority lowered. Located in Ft. Gibson segment, not Grand Lake	4	ORGANIC ENRICHMENT/ DO	LAND DISPOSAL, IN-PLACEMENT CONTAMINANTS	
OK121600010190-1998	OKLAHOMA			NEOSHO (GRAND) RIVER		Priority lowered. Located in Ft. Gibson segment, not Grand Lake	4	ORGANIC ENRICHMENT/ DO	LAND DISPOSAL, IN-PLACEMENT CONTAMINANTS	
OK121600010050-1998	OKLAHOMA			FORT GIBSON LAKE			4	NUTRIENTS	P&R LAND, NONIRR&IRR CROP PROD, URB&SURF RUNOFF, ON-SITE WSTWATER SYS, IN-PL CONTAM	
OK121600010040-1998	OKLAHOMA			NEOSHO (GRAND) RIVER		Priority lowered. Located in Ft. Gibson segment, not Grand Lake	4	NUTRIENTS	P&R LAND, NON-IRR&IRR CROP PROD, SURF RUNOFF, ON-SITE WSTWATER SYS, IN-PLACE CONTAM	
OK121600010170-1998	OKLAHOMA			LONG BAY, FT. GIBSON LAKE			4	NUTRIENTS	R LAND, NON-IRR&IRR CROP PROD, SURF RUNOFF, ON-SITE WSTWATER SYS, IN-PLACE CONTAM	

OK121600010180-1998	OKLAHOMA			NORTH BAY, FT. GIBSON LAKE			4	NUTRIENTS	P&R LAND, NON-IRR&IRR CROP PROD, SURF RUNOFF, ON-SITE WSTWATER SYS, IN-PLACE CONTAM
OK121600010150-1998	OKLAHOMA			JACKSON BAY, FT. GIBSON LAKE			4	NUTRIENTS	P&R LAND, NON-IRR&IRR CROP PROD, SURF RUNOFF, ON-SITE WSTWATER SYS, IN-PLACE CONTAM
OK121600030260-1998	OKLAHOMA			COURTHOUSE HOLLOW COVE, GRAND LAKE		Priority raised. Included in Grand Lake project. Potential Ozark cavefish habitat.	1	ORGANIC ENRICHMENT/ DO	AG, P LAND, NONIRR CRP, FDLOTS, CONST, U RUNOF, RES EXT/EXP/DEV, ONSITE WSTW, CONTAM,
OK121600030260-1998	OKLAHOMA			COURTHOUSE HOLLOW COVE, GRAND LAKE		Priority raised. Included in Grand Lake project. Potential Ozark cavefish habitat.	1	NUTRIENTS	AG, P LAND, NONIRR CRP, FDLOTS, CONST, U RUNOF, RES EXT/EXP/DEV, ONSITE WSTW, CONTAM,
OK121600030210-1998	OKLAHOMA			WEST BAY, GRAND LAKE		Priority raised. Included in Grand Lake project. Potential Ozark cavefish habitat.	1	ORGANIC ENRICHMENT/ DO	AG, P LAND, NONIRR CRP, FDLOTS, CONST, U RUNOF, RES EXT/EXP/DEV, ONSITE WSTW, CONTAM,
OK121600030210-1998	OKLAHOMA			WEST BAY, GRAND LAKE		Priority raised. Included in Grand Lake project. Potential Ozark cavefish habitat.	1	NUTRIENTS	AG, P LAND, NONIRR CRP, FDLOTS, CONST, U RUNOF, RES EXT/EXP/DEV, ONSITE WSTW, CONTAM,
OK121600030080-1998	OKLAHOMA			DUCK CREEK COVE, GRAND LAKE		Priority raised. Included in Grand Lake project. Potential Ozark cavefish habitat.	1	ORGANIC ENRICHMENT/ DO	AG, P LAND, NONIRR CRP, FDLOTS, CONST, U RUNOF, RES EXT/EXP/DEV, ONSITE WSTW, CONTAM,

OK121600030080-1998	OKLAHOMA			DUCK CREEK COVE, GRAND LAKE		Priority raised. Included in Grand Lake project. Potential Ozark cavefish habitat.	1	NUTRIENTS	AG, P LAND, NONIRR CRP, FDLOTS, CONST, U RUNOF, RES EXT/EXP/DEV, ONSITE WSTW, CONTAM,
OK121600030220-1998	OKLAHOMA			CHIGGER COVE, GRAND LAKE		Priority raised. Included in Grand Lake project. Potential Ozark cavefish habitat.	1	NUTRIENTS	AG, P LAND, NONIRR CRP, FDLOTS, CONST, U RUNOF, RES EXT/EXP/DEV, ONSITE WSTW, CONTAM,
OK121600030220-1998	OKLAHOMA			CHIGGER COVE, GRAND LAKE		Priority raised. Included in Grand Lake project. Potential Ozark cavefish habitat.	1	ORGANIC ENRICHMENT/ DO	AG, P LAND, NONIRR CRP, FDLOTS, CONST, U RUNOF, RES EXT/EXP/DEV, ONSITE WSTW, CONTAM,
OK121600030360-1998	OKLAHOMA			CAREY BAY, GRAND LAKE		Priority raised. Included in Grand Lake project. Potential Ozark cavefish habitat.	1	AMMONIA	AG P&R LAND, NONIRR C PROD, FDLOTS, CONST, URB RUNOFF, RES EXTR/EXPLOR/DEVE, CONTAM
OK121600030360-1998	OKLAHOMA			CAREY BAY, GRAND LAKE		Priority raised. Included in Grand Lake project. Potential Ozark cavefish habitat.	1	NUTRIENTS	AG P&R LAND, NONIRR C PROD, FDLOTS, CONST, URB RUNOFF, RES EXTR/EXPLOR/DEVE, CONTAM
OK121600030360-1998	OKLAHOMA			CAREY BAY, GRAND LAKE		Priority raised. Included in Grand Lake project. Potential Ozark cavefish habitat.	1	ORGANIC ENRICHMENT/ DO	AG P&R LAND, NONIRR C PROD, FDLOTS, CONST, URB RUNOFF, RES EXTR/EXPLOR/DEVE, CONTAM
OK121600030350-1998	OKLAHOMA			ECHO BAY, GRAND LAKE		Priority raised. Included in Grand Lake project. Potential Ozark cavefish habitat.	1	ORGANIC ENRICHMENT/ DO	AG P&R LAND, NONIRR C PROD, FDLOTS, CONST, URB RUNOFF, RES EXTR/EXPLOR/DEVE, CONTAM

OK121600030350-1998	OKLAHOMA			ECHO BAY, GRAND LAKE		Priority raised. Included in Grand Lake project. Potential Ozark cavefish habitat.	1	AMMONIA	AG P&R LAND, NONIRR C PROD, FDLOTS, CONST, URB RUNOFF, RES EXTR/EXPLOR/DEVE, CONTAM
OK121600030350-1998	OKLAHOMA			ECHO BAY, GRAND LAKE		Priority raised. Included in Grand Lake project. Potential Ozark cavefish habitat.	1	NUTRIENTS	AG P&R LAND, NONIRR C PROD, FDLOTS, CONST, URB RUNOFF, RES EXTR/EXPLOR/DEVE, CONTAM
OK220600010020-1998	OKLAHOMA			EUFAULA LAKE			4	FLOW ALTERATION	FLOW REGULATION/MODIFICATION
OK520500010020-1998	OKLAHOMA			EUFAULA LAKE, CANADIAN RIVER ARM, (LWR)			4	ORGANIC ENRICHMENT/DO	PASTURE LAND, RANGE LAND, NON-IRRIGATED CROP PRODUCTION
OK220600010090-1998	OKLAHOMA			EUFAULA LAKE, MILL CREEK ARM		Oilfield pollution no longer a known problem	4	NUTRIENTS	PASTURE LAND, RANGE LAND, NON-IRRIGATED CROP PRODUCTION
OK220600010090-1998	OKLAHOMA			EUFAULA LAKE, MILL CREEK ARM		Oilfield pollution no longer a known problem	4	AMMONIA	PASTURE LAND, RANGE LAND, NON-IRRIGATED CROP PRODUCTION
OK311100010030-1998	OKLAHOMA			TEXOMA LAKE, RED RIVER ARM, LOWER			3	NUTRIENTS	PASTURE LAND, NON-IRRIGATED AND IRRIGATED CROP PRODUCTION, SOURCE UNKNOWN
OK311100010080-1998	OKLAHOMA			TEXOMA LAKE, RED RIVER ARM, LOWER			3	NUTRIENTS	RANGE LAND, NON-IRRIGATED AND IRRIGATED CROP PRODUCTION, SOURCE UNKNOWN
OK310800010050-1998	OKLAHOMA			TEXOMA LAKE, WASHITA RIVER			4	NUTRIENTS	P&R LAND, NONIRR&IRR CROP PROD, SPEC CROPS, ANIMAL HOLD/MGMT, REM RIP VEG, CHANNELIZ

OK410210050020-1998	OKLAHOMA			BROKEN BOW LAKE		Source/cause codes moved from duplicate listing. Mercury detected in fish. DO added to causes.	2	ORGANIC ENRICHMENT/ DO	NPS, SURFACE RUNOFF, IN-PLACEMENT CONTAMINANTS, SOURCE UNKNOWN
OK410210050020-1998	OKLAHOMA			BROKEN BOW LAKE		Source/cause codes moved from duplicate listing. Mercury detected in fish. DO added to causes.	2	NUTRIENTS	NPS, SURFACE RUNOFF, IN-PLACEMENT CONTAMINANTS, SOURCE UNKNOWN
OK410210050010-1998	OKLAHOMA			MOUNTAIN FORK RIVER, MIDDLE		Source code 1800 added 1998 per USFWS input. Priority raised. Potential Ouachita rock-pocketbook, Winged mapleleaf habitat.	1	ORGANIC ENRICHMENT/ DO	ANIMAL HOLD/MGMT, SILVICULTURE, ATMOSPHERIC DEPOSITION, SOURCE UNKNOWN
OK410210020010-1998	OKLAHOMA			LITTLE RIVER		Source code 1800 added 1998 per USFWS input. Priority raised. Potential Ouachita rock-pocketbook, Winged mapleleaf habitat.	1	NUTRIENTS	ANIMAL HOLD/MGMT, SILVICULTURE, ATMOSPHERIC DEPOSITION, SOURCE UNKNOWN
TN05130105001-1998	TENNESSEE	STREAM/CREEK/RIVER	U CUMBERLAND	OBEY RIVER		Impacted by Dale Hollow Res. releases.	LOW	FLOW ALTERATIONS	UPSTREAM IMPOUNDMENT
TN05130108012-1998	TENNESSEE	STREAM/CREEK/RIVER	U CUMBERLAND	CANEY FORK RIVER		Center Hill Reservoir tailwater releases impact this section.	LOW	ORGANIC ENRICHMENT/ LOW DO	UPSTREAM IMPOUNDMENT

TN05130108012-1998	TENNESSEE	STREAM/CREEK/RIVER	U CUMBERLAND	CANEY FORK RIVER		Center Hill Reservoir tailwater releases impact this section.	LOW	THERMAL MODIFICATIONS	UPSTREAM IMPOUNDMENT
TN05130104048-1998	TENNESSEE	STREAM/CREEK/RIVER	U CUMBERLAND	PINE CREEK	PINE CREEK FROM MILE 13.8 TO HOWARD BAKER LAKE IS NOT SUPPORTING	Water contact advisory due to failing septic tanks. Superfund site source of organics in sediment.	HIGH	ORGANIC ENRICHMENT/ LOW DO	CHANNELIZATION, CONTAMINATED SEDIMENT, SEPTIC TANKS
TN05130108012-1998	TENNESSEE	STREAM/CREEK/RIVER	U CUMBERLAND	CANEY FORK RIVER		Center Hill Reservoir tailwater releases impact this section.	LOW	FLOW ALTERATIONS	UPSTREAM IMPOUNDMENT
TN05130202006T-1998	TENNESSEE	STREAM/CREEK/RIVER	L CUMBERLAND	CHEATHAM RESERVOIR TRIBS	PAGES BRANCH AND COOPER CR ARE NOT SUPPORTING		HIGH	ORGANIC ENRICHMENT/ LOW DO	COLLECTION SYSTEM FAILURE, LAND DEVELOPMENT, URBAN RUNOFF/STORM SEWERS
TN05130202009-1998	TENNESSEE	LAKE/RESERVOIR/POND	L CUMBERLAND	CHEATHAM RES	FROM CONF OF STONES R. TO OLD HICKORY DAM IS PARTIAL.	Nashville collection system bypassing. Also, poor quality Old Hickory Res. releases.	HIGH	ORGANIC ENRICHMENT/ LOW DO	HYDROMODIFICATION, MUNICIPAL POINT SOURCE
TN05130202009T-1998	TENNESSEE	STREAM/CREEK/RIVER	L CUMBERLAND	CHEATHAM RESERVOIR TRIBS	MANSKERS CR IS NOT SUPPORTING. DRY CR & UNNAMED TRIBS ARE PARTIALLY.	Water contact advisory on Mansker's Creek.	HIGH	ORGANIC ENRICHMENT/ LOW DO	COLLECTION SYSTEM FAILURE, LAND DEVELOPMENT
TN05130202WATGAL-1998	TENNESSEE	LAKE/RESERVOIR/POND	L CUMBERLAND	WATAUGA LAKE			LOW	NUTRIENTS	URBAN RUNOFF/STORM SEWERS
TN05130202WATGAL-1998	TENNESSEE	LAKE/RESERVOIR/POND	L CUMBERLAND	WATAUGA LAKE			LOW	ORGANIC ENRICHMENT/ LOW DO	URBAN RUNOFF/STORM SEWERS

TN05130203001-1998	TENNESSEE	STREAM/CREEK/RIVER	L CUMBERLAND	STONES RIVER	MOUTH TO P. PRIEST DAM IS PARTIALLY SUPPORTING.	Other Inorganics: manganese and sulfides below Percy Priest. Sulfides cause odor problem below dam.	LOW	FLOW ALTERATIONS	UPSTREAM IMPOUNDMENT
TN05130203001-1998	TENNESSEE	STREAM/CREEK/RIVER	L CUMBERLAND	STONES RIVER	MOUTH TO P. PRIEST DAM IS PARTIALLY SUPPORTING.	Other Inorganics: manganese and sulfides below Percy Priest. Sulfides cause odor problem below dam.	LOW	ORGANIC ENRICHMENT/ LOW DO	UPSTREAM IMPOUNDMENT
TN05130203018-1998	TENNESSEE	STREAM/CREEK/RIVER	L CUMBERLAND	WEST FORK STONES RIVER		Includes development impacts around Old Fort Parkway and Mufreesboro STP impacts.	HIGH	ORGANIC ENRICHMENT/ LOW DO	LAND DEVELOPMENT, MUNICIPAL POINT SOURCE
TN06010102001-1998	TENNESSEE	STREAM/CREEK/RIVER	HOLSTON RIVER	SOUTH HOLSTON RIVER		Below Fort Patrick Henry, the river has also been impacted by low DO in tailwaters and urban runoff. TVA tailwater improvements have helped, but not eliminated this problem.	LOW	THERMAL MODIFICATIONS	UPSTREAM IMPOUNDMENT, URBAN RUNOFF/STORM SEWERS
TN06010104003-1998	TENNESSEE	STREAM/CREEK/RIVER	HOLSTON RIVER	HOLSTON RIVER	FROM CONFLUENCE OF RICHLAND CR TO CHEROKEE DAM IS PARTIAL.	Impacted by low DO releases from Douglas Reservoir. TVA tailwater improvements have helped but have not eliminated the problem.	LOW	ORGANIC ENRICHMENT/ LOW DO	UPSTREAM IMPOUNDMENT

TN06010107001-1998	TENNESSEE	STREAM/CREEK/RIVER	FRENCH BROAD	FRENCH BROAD R	FROM GAGING STATION TO HAPPY CR. IS PARTIALLY	Impacted by Douglas Reservoir releases. Low DO and flow alteration are significant problems in tailwater releases.	LOW	NUTRIENTS	UPSTREAM IMPOUNDMENT, AGRICULTURE, LAND DEVELOPMENT
TN06010107001-1998	TENNESSEE	STREAM/CREEK/RIVER	FRENCH BROAD	FRENCH BROAD R	FROM GAGING STATION TO HAPPY CR. IS PARTIALLY	Impacted by Douglas Reservoir releases. Low DO and flow alteration are significant problems in tailwater releases.	LOW	FLOW ALTERATIONS	UPSTREAM IMPOUNDMENT, AGRICULTURE, LAND DEVELOPMENT
TN06010107006-1998	TENNESSEE	STREAM/CREEK/RIVER	FRENCH BROAD	FRENCH BROAD R		Impacted by Douglas Reservoir releases. Intensive development around Sevierville also impacting French Broad.	LOW	ORGANIC ENRICHMENT/ LOW DO	UPSTREAM IMPOUNDMENT, LAND DEVELOPMENT
TN06010107006-1998	TENNESSEE	STREAM/CREEK/RIVER	FRENCH BROAD	FRENCH BROAD R		Impacted by Douglas Reservoir releases. Intensive development around Sevierville also impacting French Broad.	LOW	THERMAL MODIFICATIONS	UPSTREAM IMPOUNDMENT, LAND DEVELOPMENT

TN06010107006-1998	TENNESSEE	STREAM/CREEK/RIVER	FRENCH BROAD	FRENCH BROAD R		Impacted by Douglas Reservoir releases. Intensive development around Sevierville also impacting French Broad.	LOW	FLOW ALTERATIONS	UPSTREAM IMPOUNDMENT, LAND DEVELOPMENT
TN06010201016-b-1998	TENNESSEE	STREAM/CREEK/RIVER	U TENNESSEE	TENNESSEE RIVER	FROM SWEETWATER CR TO FORT LOUDOU DAM	FISHING ADVISORY. TVA TAILWATER IMPROVEMENTS HAVE HELPED BUT NOT ELIMINATED, LOW DO BELOW FT. LOUDON	LOW	FLOW ALTERATIONS	UPSTREAM IMPOUNDMENT, CONTAMINATED SEDIMENT
TN06010201020-1998	TENNESSEE	LAKE/RESERVOIR/POND	U TENNESSEE	FORT LOUDOUN RESERVOIR		Fishing advisory due to PCBs. Knoxville urban runoff one source of nutrients and silt.	LOW	NUTRIENTS	CONTAMINATED SEDIMENT, URBAN RUNOFF/STORM SEWERS
TN06010201026-1998	TENNESSEE	STREAM/CREEK/RIVER	U TENNESSEE	LITTLE RIVER	INCLUDES PISTOL CREEKAND STOCK CREEK PISTOL CREEK IS NOT SUPPORTING. PORTION OF STOCK IS PARTIAL.	Fishing advisory on Little River embayment due to PCBS.	LOW	NUTRIENTS	AGRICULTURE, CONTAMINATED SEDIMENT, INDUSTRIAL POINT SOURCE, LAND DEVELOPMENT
TN06030003015-1998	TENNESSEE	STREAM/CREEK/RIVER	ELK - SHOAL	ELK RIVER	FROM BEAN'S CR TO TIMS FORD DAM IS NOT SUPPORTING.	Tailwater releases from Tims Ford Reservoir impact Elk River. TVA tailwater improvements have helped but not eliminated this situation.	LOW	ORGANIC ENRICHMENT/ LOW DO	UPSTREAM IMPOUNDMENT

TN06030003015-1998	TENNESSEE	STREAM/CREEK/RIVER	ELK - SHOAL	ELK RIVER	FROM BEAN'S CR TO TIMS FORD DAM IS NOT SUPPORTING.	Tailwater releases from Tims Ford Reservoir impact Elk River. TVA tailwater improvements have helped but not eliminated this situation.	LOW	FLOW ALTERATIONS	UPSTREAM IMPOUNDMENT
TN06030003015-1998	TENNESSEE	STREAM/CREEK/RIVER	ELK - SHOAL	ELK RIVER	FROM BEAN'S CR TO TIMS FORD DAM IS NOT SUPPORTING.	Tailwater releases from Tims Ford Reservoir impact Elk River. TVA tailwater improvements have helped but not eliminated this situation.	LOW	THERMAL MODIFICATIONS	UPSTREAM IMPOUNDMENT
TN06030003035-1998	TENNESSEE	STREAM/CREEK/RIVER	ELK - SHOAL	ELK RIVER	FROM TIMS FORD RES TO WOODS RES DAM		LOW	ORGANIC ENRICHMENT/ LOW DO	UPSTREAM IMPOUNDMENT
TN06030003035-1998	TENNESSEE	STREAM/CREEK/RIVER	ELK - SHOAL	ELK RIVER	FROM TIMS FORD RES TO WOODS RES DAM		LOW	FLOW ALTERATIONS	UPSTREAM IMPOUNDMENT
TN06030003053-1998	TENNESSEE	STREAM/CREEK/RIVER	ELK - SHOAL	ROCK CREEK		Area impacts include Tullahoma STP.	LOW	ORGANIC ENRICHMENT/ LOW DO	MUNICIPAL POINT SOURCE, LAND DEVELOPMENT
TN06030003053-1998	TENNESSEE	STREAM/CREEK/RIVER	ELK - SHOAL	ROCK CREEK		Area impacts include Tullahoma STP.	LOW	FLOW ALTERATIONS	MUNICIPAL POINT SOURCE, LAND DEVELOPMENT
TN06030003053-1998	TENNESSEE	STREAM/CREEK/RIVER	ELK - SHOAL	ROCK CREEK		Area impacts include Tullahoma STP.	LOW	THERMAL MODIFICATIONS	MUNICIPAL POINT SOURCE, LAND DEVELOPMENT
TN06040005022-1998	TENNESSEE	LAKE/RESERVOIR/POND	W TENNESSEE	WEST SANDY EMBAYMENT			LOW	NUTRIENTS	UPSTREAM IMPOUNDMENT, SEPTIC TANKS, RECREATIONAL ACTIVITIES
TN06040005022-1998	TENNESSEE	LAKE/RESERVOIR/POND	W TENNESSEE	WEST SANDY EMBAYMENT			LOW	ORGANIC ENRICHMENT/ LOW DO	UPSTREAM IMPOUNDMENT, SEPTIC TANKS, RECREATIONAL ACTIVITIES
VAS-O02R-1998	VIRGINIA	STREAM/CREEK/RIVER	TENNESSEE AND BIG SANDY RIVER BASINS	SOUTH FORK HOLSTON RIVER - UT	WASHINGTON			AMMONIA	

WI-LC-109-093-Eau_Galle_River-1998	WISCONSIN	STREAM/CREEK/RIVER	LC	EAU GALLE RIVER	ST. CROIX, PIERCE			THERMAL MODIFICATIONS	NONPOINT SOURCES
WI-LC-109-093-Eau_Galle_River-1998	WISCONSIN	STREAM/CREEK/RIVER	LC	EAU GALLE RIVER	ST. CROIX, PIERCE			NUTRIENTS	NONPOINT SOURCES

Appendix 4: Description of candidate pollutant trading projects identified in the survey of hydropower projects experiencing water quality concerns, Mississippi River Basin – July 2000.

There were 55 candidate trading projects identified in the screening phase of this study. The projects are identified by hydropower project and grouped according to their respective sub-basin within the Mississippi River Basin, i.e., Arkansas/White/Red, Missouri, Ohio, Tennessee, Upper Mississippi, and Lower Mississippi. Within each sub-basin the projects are listed in descending order from the headwater tributaries to the main river of each sub-basin.

The candidate trading projects varied in size, complexity, and the type of trading option they presented. For example, the South Fork Holston River flows through a heavily developed stream segment in Kingsport, TN. Both municipal and industrial point sources installed new waste treatment facilities in the 1980's and are meeting their technology based NPDES permit requirements. However, in-stream water quality standards are not being met. An exploratory analysis by the state of Tennessee, Environmental Protection Agency, Tennessee Valley Authority, and various stakeholders indicated that innovative solutions could achieve water quality objectives for $395,000 per year (1997 $'s); whereas, effluent management methods could not meet standards at an annual cost of nearly $44 million per year. The innovative solutions included pulsing upstream hydropower turbines to achieve a 400 cubic feet per second increase in flow and aerating hydro-turbine releases an additional 3.0 milligrams per liter (mg/l) to meet a dissolved oxygen (DO) objective of 6.0 mg/l. Pollutant credits would be created for any DO improvements above the state's standard of 5.0 mg/l and sold to the downstream dischargers to offset lost power revenues, cost of aeration, etc. This pollutant trading scenario would be considered an example of a "Facility Trading Option".

Another situation could involve multiple TMDL's, multiple sources of pollution, and the need to examine the project from a more holistic, watershed perspective. For example, the Cumberland River near Nashville, Tennessee has two major hydropower projects, Old Hickory and Cheatham, that are experiencing water quality problems. Releases from Old Hickory Reservoir are low in DO and they flow into the reservoir created by Cheatham Dam. The situation is exacerbated by pollutant loads from Nashville's failing collection system, municipal point sources, urban runoff, land development, and hydromodifications. There is also a third hydro project, J. Percy Priest, located on the Stones River that joins the Cumberland River a few miles upstream of Nashville, but downstream of Old Hickory Hydro. The Stones River has three TMDL concerns, 2 downstream from J. Percy Priest Dam and 1 in the upstream reservoir on the West Fork of the Stones River. "Organic enrichment/low DO" and "flow alteration" problems are found downstream of J. Percy Priest. The West Fork of the Stones River is experiencing "organic enrichment/low DO" problems that were attributed to land development and discharges from Mufreesboro's wastewater treatment plant. Preliminary evaluations indicate a watershed trading scenario to improve water quality in the Cumberland River may require the following:

(1) point/nonpoint trading to reduce inflow pollutant loads to the Old Hickory, J. Percy Priest, and Cheatham reservoirs; and

(2) nonpoint/nonpoint and nonpoint/point trading between the hydropower projects and sources in the Nashville metropolitan area.

(Note: The pollutant trading scenario described in this situation would be an example of a "Watershed Trading Option".)

ARKANSAS/WHITE/RED RIVER SUB-BASIN

ARKANSAS RIVER TRIBUTARIES

Kaw Hydro – Arkansas River (Oklahoma)

Kaw Dam impounds the Arkansas River to form Kaw Lake. The project is located near Ponca City, Oklahoma and is about 60 miles northwest of Tulsa. There are 5 TMDL sites and 13 TMDL files associated with Kaw Lake. The 5 sites have between 1 and 4 TMDL files or water quality concerns per site. For example, the Oklahoma Department of Environmental Quality (DEQ) has identified nutrients, organic enrichment/DO, thermal stratification, and flow alteration as concerns in the Arkansas River Arm of Kaw Lake (Appendix 2). Nutrients are a concern at all 5 sites, followed by organic enrichment/DO at four sites, and flow alteration and thermal stratification at 2 sites. The water quality problems are attributed to a variety of non-point sources, i.e., prairie and rangelands, non-irrigated crop production, highway maintenance and runoff, urban runoff, and pastureland along with some petroleum activities. The Oklahoma DEQ has designated the reservoir TMDLs as priority 4 sites and the Arkansas River sites as priority 3 and 4, respectively. (Note: Kaw Hydro is owned by the Oklahoma Municipal Power Authority. The project is subject to re-licensing by the Federal Energy Regulatory Commission (FERC), project # 3063, license expiration: October 31, 2034.)

Keystone Hydro – Arkansas River (Oklahoma)

Keystone Hydro is a USACE project located downstream of Kaw Lake on the Arkansas River and west of Tulsa. The reservoir pool includes the confluence of the Cimarron and Arkansas Rivers. There are 6 TMDL sites and 13 TMDL files associated with Keystone Hydro. The 6 TMDL sites have between 1 and 4 TMDL files or water quality concerns per site. The state of Oklahoma has identified nutrients, organic enrichment/DO, thermal stratification, and flow alteration as water quality concerns. Nutrients are a concern at 5 sites; organic enrichment and thermal modification at 3 sites; and flow alteration is a concern at 2 sites. The water quality concerns are attributed to pollutant runoff from prairie and rangelands, crop production, highway maintenance/runoff, in-place contaminants, removal of riparian vegetation, and natural sources. One TMDL site also identified petroleum activities as a concern. The Oklahoma DEQ has designated the reservoir TMDL's as priority 3 sites and the Arkansas River sites as priority 2.

Pensacola Hydro – Neosho (Grand) River (Oklahoma)

One of the major tributaries of the Arkansas River in eastern Oklahoma is the Neosho or Grand River. In the northeastern corner of the state the Pensacola Dam impounds the Neosho River to create the Grand Lake O' the Cherokees. The river and its impoundment are also called the Grand Lake Project. There are 17 TMDL sites and 37 TMDL files associated with Pensacola Hydro. The 17 sites have between 1 and 3 TMDL files or water quality concerns per site. Nutrients and organic enrichment/DO are a concern at 16 sites, and ammonia is a concern at 5 sites. The state of Oklahoma has made the Grand Lake Project a high priority project because of water quality in the lake and its potential impact on habitat for endangered species (Ozark cavefish, Neosho madtom, and Winged mapleleaf madtom). The water quality concerns are all non-point in origin and include prairie and range lands, non-irrigated crop production, feedlots, activities related to animal holding and management, construction activities, urban runoff, on-site wastewater systems, land disposal, recreational activities, unknown sources, in-placement contaminants, and resource exploration-development-extraction. The Oklahoma DEQ has designated the Grand Lake Project a priority 1. (Note: The Grand River Dam Authority owns Pensacola Dam. The project is subject to re-licensing by FERC, project # 1494, license expiration: March 31, 2022.)

Robert S. Kerr Hydro – Neosho (Grand) River (Oklahoma)

The Robert S. Kerr Hydro is located on the Neosho (Grand) River downstream of the Pensacola Hydro Project. (Note: This project should not be confused with Robert S. Kerr Lock and Dam on the Arkansas River which is also in eastern Oklahoma.) There are 2 TMDL sites associated with Robert S. Kerr Hydro. Both sites have identified organic enrichment/low DO as a concern. The pollutant problems are attributed to surface mining activities and in-placement contaminants. One of the TMDL sites has also identified flow regulation/modification as a concern. (Note: This project is owned by the Grand River Dam Authority and is licensed by FERC. It is called the Markham Ferry project by FERC, project #2183, license expiration: May 31, 2005.)

Fort Gibson Hydro – Neosho River (Oklahoma)

Fort Gibson Hydro is a USACE project located downstream of Pensacola Hydro on the Neosho River (Grand River). It is east of Tulsa and has seven TMDL sites associated with it. Four of the sites are located within the lake (the main body of the lake and three of the lake's embayments). The concern at all 4 sites is nutrients. There are also 3 TMDL sites located in the riverine portion of the project and they cite organic enrichment/low DO (2 sites) and nutrients (1 site) as a concern. Pollutant loadings have been attributed to prairie and rangelands, non-irrigated and irrigated crop production, on-site wastewater systems, and in-placement contaminants. Three of the TMDL sites also have runoff from urban runoff and/or land disposal activities. The Oklahoma DEQ has designated these TMDL sites as a priority 4.

Webber Falls L&D – Arkansas River (Oklahoma)

Webber Falls L&D is located is a USACE project on the Arkansas River between Tulsa and the OK-AR state line. There are two priority 1 TMDL sites on the Arkansas River near Muskogee with nutrients and organic enrichment/low DO concerns at each site. The water quality problems are attributed to pollutants from prairie and range lands, feedlots of all types, and land disposal. There is also a priority 2 TMDL site with nutrient concerns. The nutrients are attributed to storm sewers and non-point pollutants from prairie and rangelands, feedlots, non-irrigation crop production, surface mining, and dam construction.

Tenkiller Hydro – Illinois River (Oklahoma)

Tenkiller Hydro is a USACE project located on the Illinois River in eastern Oklahoma and the river is a major tributary of the Arkansas River. There are 8 TMDL sites and 18 TMDL files associated with Tenkiller Hydro. Each site has between 1 and 4 files or water quality concerns per site. Organic enrichment/DO is a concern at every site. Nutrients are a concern at 6 sites and flow alteration is a concern at 4 sites. The water quality problems are associated with runoff from prairie and range lands, animal feedlots, flow regulation/modification, non-irrigated crop production, land development, animal holding and management, highways/bridges. The Oklahoma DEQ has identified these TMDL sites a priority 1 and they are part of the designated Illinois River Project.

Eufaula Hydro – Canadian River (Oklahoma)

Eufaula Hydro is a USACE project located on the Canadian River just upstream of its confluence with the Arkansas River in eastern Oklahoma. It's about 50 miles south of Tulsa and 100 miles east of Oklahoma City. There are 5 TMDL sites and 6 TMDL files associated with Eufaula Hydro. Organic enrichment/DO is a concern at 3 sites. Nutrients and ammonia are a concern in the Mill Creek Arm of Eufaula Lake, and flow alteration is a concern at one site in the lake. The water quality problems are attributed to runoff from pasture land, range lands, and non-irrigated crop production at the sites experiencing organic enrichment, nutrients, and ammonia concerns. The flow alteration is also a concern in Eufaula Lake. The Oklahoma DEQ has designated the TMDL's in Eufaula Lake as priority 4 sites and the 2 TMDL sites experiencing organic enrichment/DO as priority 2 and 3 sites, respectively.

RED RIVER TRIBUTARIES

Denison Hydro – Red River (Oklahoma)

Denison Hydro is a USACE project is located near Durant, Oklahoma on the Oklahoma/Texas state line. The upstream reservoir is called Lake Texoma and it has three TMDL sites. One site is located on the Washita River Arm of the reservoir and the other two are located on the Red River Arm. Nutrients are the major concern and they are attributed to runoff from range and pasture land, irrigated and non-irrigated crop production, specialty crops, animal holding/management, removal of riparian vegetation, and channelization. These sites are considered priority 3 and 4 sites by the state of Oklahoma.

Broken Bow Hydro – Mountain Fork (Oklahoma)

Broken Bow Hydro is a USACE project located in southeastern Oklahoma on Mountain Fork, a tributary of the Red River. There are 3 TMDL sites and 4 TMDL files associated with Broken Bow Hydro. Nutrients and/or organic enrichment/DO are a concern at each site. The water quality problems in Broken Bow Lake are attributed to agricultural operations, in-placement contaminants, and unknown sources. The water quality problems in the Little River and Mountain Fork River are attributed to animal holding/management, atmospheric deposition, and unknown sources. The state has identified the tributary sites as priority 1 sites and Broken Bow Lake as priority 2 sites.

MISSOURI RIVER SUB-BASIN

<u>MISSOURI RIVER AND TRIBUTARIES – BIG HORN RIVER, NORTH PLATTE RIVER, AND BIG BLUE RIVERS</u>

Yellowtail Hydro and Yellowtail Afterbay – Bighorn River (Wyoming/Montana)

The Bighorn River TMDL's are found in the stream reach near Hardin, Montana. Hardin and are located near the north/central border of the Crow Indian Reservation. They are also downstream of the Bureau of Reclamation's Yellowtail Dam and Yellowtail Afterbay. Aquatic life and drinking water uses are impaired due to flow alterations, organics, salinity, suspended solids, thermal modifications, pH, and inorganics associated with agriculture, flow regulation/modification, the upstream impoundment, and natural resources. The 3 TMDL's for this project are organic enrichment/low dissolved oxygen, thermal modifications, and flow alteration. The state of Montana considers Yellowtail Hydro TMDL sites a low priority. (Note: The Bighorn River is a Yellowstone River, which joins the Missouri River in North Dakota.)

Canyon Ferry Hydro – Upper Missouri River (Montana)

Canyon Ferry Hydro is a Bureau of Reclamation project located near Townsend, Montana. The TMDL site is the upper end of the reservoir. Recreational use is impaired in 35,180 acres of the reservoir due to noxious aquatic plants and pathogens that are associated with agricultural runoff, land development and failing septic systems. Nutrients have been identified as the TMDL concern. The state of Montana has identified this project as a low priority.

Holter Hydro – Upper Missiouri River (Montana)

Holter Hydro is owned by the Montana Power Company. Noxious plants impair recreational use in 4,800 acres of Holter Lake. Surplus nutrients in the lake are attributed to agricultural runoff and other land development. The TMDL concern is nutrients.

A section of the Missouri River also suffers from nutrient enrichment. The nutrients are attributed to the upstream impoundment(s), agriculture, irrigated crop production, rangeland, stream bank modification/stabilization, and natural sources. The state of Montana has identified this project as a low priority.

Fort Peck Hydro – Missouri River (Montana)

Fork Peck Hydro is a USACE project on the main stem of the Missouri River near Glasgow, Montana. The lands surrounding the upstream reservoir make up the Charles M. Russell National Wildlife Refuge. The TMDL concerns for the reservoir are organic enrichment/low dissolved oxygen, nutrients, and flow alteration. The water quality concerns are attributed to runoff from agriculture, flow regulation/modification, irrigated crop production, rangeland, and natural sources. The TMDL sites are considered a low priority by the state of Montana.

Holmesville/Blue Springs Hydro's – Big Blue River (Nebraska)

Nebraska Public Power District owns the Holmesville and Blue Spring Hydro's. They are located on the Big Blue River in the southeastern corner of Nebraska near the towns of Holmesville and Blue Springs. The Big Blue River has two TMDL sites with un-ionized ammonia concerns. The ammonia (un-ionized) is attributed to an industrial point source and a municipal point source. The TMDL sites are considered a low priority by the state of Nebraska.

Harry S. Truman Hydro – Lower Missouri (Missouri)

Harry S. Truman Hydro is a USACE project on the Osage River near Warsaw, Missouri. The project has one TMDL site that is experiencing problems with low dissolved oxygen and gaseous supersaturation. At certain times of the year this condition causes fish trauma and affects a 50 mile section of the river. The state of Missouri has identified this project as a medium priority.

Table Rock Hydro – Lower Missouri (Missouri)

Table Rock Hydro is a USACE project on the White River near Branson, Missouri. The project is experiencing low dissolved oxygen problems which affects 1730 acres. The Corps of Engineers has installed turbine venting to increase DO and is working on an aeration option feasibility study. The state of Missouri has identified this project as a medium priority.

UPPER MISSISSIPPI SUB-BASIN

Prairie River Hydro – Prairie River (Minnesota)

The Prairie River Hydro is owned by Minnesota Power & Light Company and the dam is located on the Prairie River near Grand Rapids, Minnesota. The TMDL site extends from the Grand Rapids Dam to the Prairie River drainage area. The TMDL concern is low dissolved oxygen. The state of Minnesota does not consider this TMDL site a priority. (Note: This project is subject to re-licensing by FERC, project # 2361, license expiration December 31, 2023.)

Brainerd Hydro – Mississippi River (Minnesota)

The Brainerd Hydro is owned by Potlatch Corporation and the dam is located on the Mississippi River near Brainerd, Minnesota. The Mississippi River TMDL site extends from the Pine River to Brainerd Dam. The TMDL concern is low dissolved oxygen. The state of Minnesota does not consider this TMDL site a priority. (Note: This project is subject to re-licensing by FERC, project 2533, license expiration February 28, 2023.)

Eau Galle Hydro – Eau Galle River (Wisconsin)

The Eau Galle Hydro is a privately owned project located on the Eau Galle River near the town of Eau Galle, Wisconsin. The TMDL concerns are thermal modification and nutrients. The TMDL concerns are attributed to nonpoint sources. The state of Wisconsin does not consider this TMDL site a priority.

Anamosa Hydro – Wapsipinicon River (Iowa)

Anamosa Hydro is owned by Iowa Electric Light & Power Company. The project is located in eastern Iowa near the town of Anamosa. The Wapsipinicon River has two ammonia TMDL sites that were added by EPA. The Iowa Department of Natural Resources has not assigned a priority to this site.

Waverly Milldam Hydro – Cedar River (Iowa)

Waverly Milldam Hydro is located on the Cedar River and owned by the city of Waverly. It is also located upstream of 3 communities; Cedar Falls, Waterloo, and La Porte, that have ammonia TMDL's that have been added to Iowa's TMDL list by EPA. The Iowa Department of Natural Resources has not assigned a priority to this site.

Five In One Hydro – Red Cedar River (Iowa)

Five in One Hydro is located on the Red Cedar River and is owned by the city of Cedar Rapids. There is a TMDL site for ammonia downstream of the dam. The Iowa Department of Natural Resources has not assigned a priority to this site

Iowa Falls Milldam Hydro – Iowa River (Iowa)

Iowa Falls Milldam Hydro is owned by Iowa Electric Light & Power Company. The project is located on the Iowa River near Iowa Falls, Iowa. There are 3 TMDL sites along the Iowa River with ammonia concerns. EPA added the sites to Iowa's TMDL list. The Department of Natural Resources has not assigned a priority to this site.

Ottumwa Hydro – Des Moines River (Iowa)

The Ottumwa Hydro is located on the Des Moines River and is owned by the city of Ottumwa. There is a TMDL site for ammonia downstream of the dam. The Department of Natural Resources has not assigned a priority to this site. (Note: The project is subject to re-licensing by FERC, project # 925, license expiration: April 30, 2008.)

19 Hydro – Mississippi River (Iowa)

Lock & Dam 19 Hydro is a U.S. Army Corps of Engineer's project on the Mississippi River near Keokuk, Iowa. The river upstream of the dam to the confluence with the Skunk River, a distance of 25 to 30 river miles, is experiencing ammonia and ammonia-nitrogen problems. EPA added 3 TMDL sites to Iowa's TMDL list. No source or site information was available. The Iowa Department of Natural Resources has identified these TMDL sites as a low priority.

Dayton Hydro – Fox River (Illinois)

The Dayton Hydro is owned by Midwest Hydro, Inc. The project is located on the Fox River near Dayton, Illinois. There is 1 TMDL site on the Fox River with nutrients and organic enrichment/low DO concerns. The other TMDL site is a "lake/reservoir/pond" site with nutrient concerns. The nutrient and organic enrichment/low DO concerns in the Fox River are attributed to pollutant loadings from agriculture, non-irrigated crop production, resource extraction, and petroleum activities. The lake/reservoir/pond nutrient concerns are attributed to agriculture, non-irrigated crop production, land development, urban runoff/storm sewers, land disposal, wastewater systems, hydrologic/habitat modification, and dredging. The Illinois Environmental Protection Agency has not assigned a priority to these TMDL sites. (Note: This project is subject to re-licensing by FERC, project # 281, license expiration: April 10, 2004.)

Rockton, Dixon, and Sears Hydro – Rock River (Illinois)

Rockton and Dixon Hydro's are owned by South Beloit Water, Gas & Electric Company and STS Hydropower, Ltd, respectively. The 3 low volume hydro projects are located on the Rock River near the towns of Rockton, Dixon, and Rock Island, Illinois. The dams are located near the Illinois/Wisconsin state line (Rockton, mile 0), mid-way on the Rock River in Illinois (Dixon, mile 50), and at the confluence of the Rock River with the Mississippi River (Rock Island, mile 120). The TMDL's for the Rock River involve nutrients and flow alteration. The TMDL's concerns are attributed to agriculture, non-irrigated crop production, pastureland, hydrologic/habitat modification, and flow regulation/modification. The Illinois Environmental Protection Agency has not assigned a priority to these TMDL sites. (Note: The Rockton and Dixon projects are subject to re-licensing by FERC, project #'s 2373-Rockton and 2446-Dixon, license expiration: December 31, 2023.

Leclaire Hydro – Illinois River (Illinois)

Leclaire Hydro is owned by the city of Leclaire. It is located on the Illinois River which has a TMDL site which identifies nutrients and flow alteration as concerns. The Illinois Environmental Protection Agency has not assigned a priority to this TMDL site. (Note: This project is licensed by FERC, project # 3862, license expiration: February 29, 2044.)

Starved Rock Hydro – Illinois River (Illinois)

Starved Rock Hydro is owned by the city of Peru. It has a TMDL site which identifies nutrients and flow alteration as concerns. The Illinois Environmental Protection Agency has not assigned a priority to this site. (Note: This project is subject to re-licensing by FERC, project # 4031, license expiration: May 31, 2038.)

Chicago Sanitation & Ship Canal Hydro (Illinois)

The Chicago Sanitation & Ship Canal Hydro is associated with 5 TMDL sites. The TMDL concerns are nutrients, ammonia, organic enrichment/DO, and flow alterations. The TMDL concerns are attributed to industrial and municipal point sources, combined sewer overflows, urban runoff/storm sewers, hydrologic/habitat modification, channelization, flow regulation/modification, in-place contaminants, and other. The Illinois Environmental Protection Agency has not assigned a priority to these TMDL sites. (Note: This project would include Lockport Hydro that is owned by the Metropolitan Sanitation District of Greater Chicago. It is licensed by FERC, project # 2866, license expiration: November 30, 2001.)

Mississippi River Hydro – Mississippi River (Illinois)

There are 37 TMDL sites on the Mississippi River in the State of Illinois. The main concern is nutrients, although 3 sites include flow alteration as a concern. The pollutant problems for 23 TMDL's are attributed to industrial and municipal point sources, agriculture, non-irrigated crop production, urban runoff/storm sewers, combined sewer overflows, and hydrologic/habitat modification. The other 14 TMDL's concerns are attributed to agriculture and hydrologic/habitat modification. The Illinois Environmental Protection Agency has not assigned a priority to these TMDL sites.

Power Dam, Moline Power Dam, and Lock & Dam 19 Hydro. The first two dams are near Moline, Illinois and the third is near Keokuk, Iowa. The dams are approximately 95 river miles apart. (Note: These projects are also described in the TMDL's for Iowa.)

OHIO RIVER SUB-BASIN

OHIO RIVER TRIBUTARIES – DIX AND SCIOTO RIVERS

Dix River Hydro—Dix River (Kentucky)

Dix River Hydro is located on the Dix River and impounds Herrington Lake, which is about 20 miles southwest of Lexington, KY. There is one TMDL site for Lake Herrington and the concern is organic enrichment/low DO. The Kentucky Division of Environmental Protection is currently completing the TMDL for Herrington Lake.

O'Shaughnessy Hydro – Scioto River (Ohio)

The Scioto River has a number of TMDL sites from its headwaters in north central Ohio to its confluence with the Ohio River near Portmouth, Ohio. Three TMDL sites for nutrients (2) and organic enrichment/DO are associated with O'Shaughnessy Hydro and J. Griggs Reservoir just north of Columbus, Ohio. As the Scioto River winds through Columbus it receives flows from the Olentangy River and Big Walnut Creek. Each stream has an upstream, non-hydropower impoundment. Delaware Lake is on the Olentangy River and Hoover Reservoir is on Big Walnut Creek. The stream segment downstream of these impoundments have flow alteration, ammonia, organic enrichment/DO, and thermal modification concerns. The TMDL concerns are attributed to industrial and municipal point sources, non-irrigated crop production, irrigated crop production, range and pastureland, feedlots, land development, hydromodification, upstream impoundment, flow regulation/modification, and urbanization.

Hargus Creek joins the Scioto River about 20 miles downstream of Columbus, Ohio. A non-hydropower dam, Hargus Lake, is located on Hargus Creek. The lake has nutrients, ammonia, organic enrichment/DO, and flow alteration TMDL's. The creek has organic enrichment/DO concerns. The TMDL concerns are attributed to municipal point sources, urban runoff/sewer overflow, combined sewer overflow, and on-site waste systems.

Deer Creek joins the Scioto River approximately 20 miles downstream of its confluence with Hargus Creek. Deer Creek has two non-hydropower impoundments, Deer Creek Lake and Madison Lake. Both lakes have nutrients and organic enrichment/DO TMDL's, and Deer Creek Lake has ammonia concerns. The TMDL concerns are attributed to agriculture, pasture and rangeland, non-irrigated crop production.

Paint Creek joins the Scioto River approximately 10 miles downstream of its confluence with Deer Creek and just south of Chillicothe, Ohio. Paint Creek has three non-hydropower impoundments; Rocky Fork Lake, Hillsboro Reservoir, and Paint Creek Lake. TMDL's for these lakes include nutrients and organic enrichment/DO. The TMDL concerns are attributed to industrial and municipal point sources, agriculture, and non-irrigated crop production. (Note: The Ohio Environmental Protection Agency has not assigned a priority to these TMDL sites. It should also be pointed out that this is the only project that considered the possible integration of hydropower and water supply reservoirs into a "Watershed Trading Option". And, lastly, O'Shaughnessy Hydro is owned by the city of Columbus, Ohio.)

OHIO RIVER - CUMBERLAND RIVER AND ITS TRIBUTARIES

Center Hill Hydro—Caney Fork River (Tennessee)

Center Hill Hydro is a USACE project located on the Caney Fork River about 50 miles east of Nashville. The tailwater is a designated TMDL site suffering from organic enrichment/low DO, flow alterations, and thermal modifications. The source is the upstream impoundment. The state of Tennessee has identified this project as a low priority.

Old Hickory, J. Percy Priest, and Cheatham Hydros - Cumberland and Stones River (Tennessee)

Old Hickory and Cheatham Hydros are USACE projects on the Cumberland River. Old Hickory is upstream from Nashville about 10 miles to the northeast, and Cheatham is downstream about 25 miles west of Nashville. The Cumberland River passes through Nashville. The Stones River enters Cheatham Reservoir a few miles downstream from Old Hickory Dam and upstream from Nashville. It is impounded by J. Percy Priest Dam, which is located about six miles upstream from the mouth of the Stones River.

There are three TMDL sites in Cheatham Reservoir and the cause for each one is organic enrichment/low DO. The sources include the Nashville collection system failure/bypassing, municipal point source, urban runoff/storm sewers, land development, and hydromodification. The sources are also impacted by turbine releases with poor quality from Old Hickory Reservoir. All three TMDL sites are designated as high priority.

There are three TMDL sites on the Stones River, two downstream from J. Percy Priest Dam and one upstream of the reservoir on the West Fork of the Stones River. The causes downstream from the dam are organic enrichment/low DO and flow alterations, and the source is the dam. The cause also includes manganese and sulfides below Percy Priest (sulfides cause an odor problem below the dam.) The TMDL site on the West Fork of the Stones is caused by organic enrichment/low DO, and the source is land development and a municipal point source. Land development is causing impacts around Old Fort Parkway, and the municipal point source is from Murfreesboro STP impacts. The TMDL site on the West Fork of the Stones River is listed as a high priority. The

TMDL site in the West Fork of the Stones River may affect water quality in J. Percy Priest Reservoir and may be an opportunity for trading. (Note – The state of Tennessee has identified these projects as a high priority.)

Barkley Hydro—Cumberland River (Kentucky)

Barkley Hydro is a USACE project located on the Cumberland River. There is a TMDL site on the Little River which discharges into Lake Barkley about 20 miles west of Hopkinsville, KY, which is about 50 miles northwest of Nashville, TN. The cause of the TMDL is nutrients, but the actual location of the TMDL needs to be determined to see if it impacts the Little River arm of Lake Barkley. The Little River arm is the largest arm of Lake Barkley other than the Cumberland River arm. The source of the TMDL was not given, but the state of Kentucky has designated it a "first priority."

TENNESSEE RIVER SUB-BASIN

TENNESSEE RIVER TRIBUTARIES – HOLSTON, WATAUGA, AND FRENCH BROAD RIVERS

South Holston Hydro—South Holston River (Virginia/Tennessee)

South Holston Hydro is a TVA project on the south Holston River just downstream from the Virginia-Tennessee state line. The waters impounded by South Holston Dam extend upstream into Virginia. Virginia has designated the South Holston River as a TMDL site. The TMDL cause is ammonia. (Note: The state of Virginia has designated a priority for this site.)

Fort Patrick Henry Hydro—South Holston River (Tennessee)

Fort Patrick Henry Hydro is a TVA project located on the South Holston River upstream from Kingsport, Tennessee. The river downstream from Fort Patrick Henry Hydro is a TMDL site caused by thermal modifications. The source is the dam, urban runoff and storm sewers. The Tennessee Division of Water Quality states the river below Fort Patrick Henry has been impacted by low DO and urban runoff, and that TVA's tailwater improvements have helped, but not eliminated the problem. (Note: The state of Tennessee has identified this site as a low priority.)

Cherokee Hydro—Holston River (Tennessee)

Cherokee Hydro is a TVA project on the Holston River about midway between Knoxville and Kingsport, Tennessee. The river downstream from Cherokee has been designated as a TMDL site. The cause is organic enrichment/low DO. The source is the upstream impoundment. The Tennessee Division of Water Quality states that the river is impacted by low DO in the releases from Cherokee Reservoir. TVA's tailwater improvements have helped but have not eliminated the problem. TVA has stated that part of the low DO problem in the releases from Cherokee is due to nonpoint (and possible point) sources in the upstream watershed. This represents a potential trading opportunity where TVA could increase the DO in the releases from Cherokee Dam and recover part of the costs from sources in the upstream watershed. (Note: The state of Tennessee has identified this site as a low priority.)

Watauga Hydro—Watauga River (Tennessee)

Watauga Hydro is a TVA project located on the Watauga River in northeast Tennessee about five miles east of Elizabethton. The lake has two TMDL sites that are caused by organic enrichment/low DO and nutrients. The sources are urban runoff and storm sewers. (Note: The state of Tennessee has identified this site as a low priority.)

Douglas Hydro—French Broad River (Tennessee)

Douglas Hydro is a TVA project located on the French Broad River about 25 miles east of Knoxville and about 10 miles north of Pigeon Forge/Sevierville, a popular tourist area. Significant development is now occurring along the river downstream of Douglas Hydro.

The river has five TMDL sites and the causes include organic enrichment/low DO, nutrients, thermal modifications, and flow alterations. The sources include the upstream impoundment, agriculture, and intensive land development around Pigeon Forge and Sevierville. There is potential for a trading project for the DO and other water quality issues in the releases from Douglas. TVA is already increasing DO in the releases from Douglas that they believe are attributable to the reservoir itself. Additional DO improvement may be attained through nonpoint sources controls in the upstream watershed. A “Watershed Trading Option” may be the solution to additional water quality improvements. (Note: The state of Tennessee has identified this as a low priority site.)

<u>TENNESSEE RIVER</u>

Fort Loudoun Hydro—Tennessee River (Tennessee)

Fort Loudoun Hydro is a TVA project located on the Tennessee River downstream from Knoxville. Three TMDL sites are in the vicinity of Fort Loudoun Hydro including the tailwater, the reservoir itself, and a major tributary -- the Little River. Nutrients are the cause for the two sites upstream from the dam, and flow alteration is the cause for the site downstream from the dam. The source for the reservoir site is urban runoff/storm sewers. The source for the Little River is agriculture, industrial point source, and land development. The source for the tailwater is the upstream impoundment. There may be opportunity for trading between TVA and the sources, because TVA can probably aerate portions of the reservoir and the turbine discharges for much less cost than the control of urban runoff, storm water discharges, and industrial point sources. TVA already aerates the turbine discharges up to the DO level that it considers is attributable to the impoundment. (Note: The state of Tennessee has identified this site as a low priority.)

Guntersville Hydro—Tennessee River (Alabama)

Guntersville Hydro is a TVA project located on the Tennessee River about 25 miles southeast of Huntsville, Alabama. The reservoir pool extends upstream to the Alabama-Tennessee-Georgia state lines. There are three TMDL sites on tributaries of the reservoir, but two of them are at the same location (with different causes) and apparently end where the tributaries enter the embayment. These two have very low potential for being addressed by reservoir enhancements. The other TMDL site on Mud creek embayment has potential for reservoir enhancement. The cause of the TMDL is organic enrichment/low DO and the sources are non-irrigated crop production and pasture grazing. (Note: The state of Alabama has identified this site as a low priority.)

Tims Ford Hydro—Elk River (Tennessee/Alabama)

Tims Ford Hydro is a TVA project located on the Elk River about 50 miles west of Chattanooga. There are eight TMDL sites in the vicinity of Times Ford Dam and Reservoir. Three sites are on Rock Creek that discharges into Times Ford Reservoir, two sites are on the reservoir, and three sites are downstream. The Rock Creek sites are caused by organic enrichment/low DO, flow alterations, and thermal modifications for which the sources are wastewater discharges from Tullahoma as well as land development in the Tullahoma area. The in-lake sites are caused by organic enrichment/low DO and flow alterations for which the source is an upstream impoundment, Woods Reservoir. The three TMDL sites downstream of Tims Ford are affected by organic enrichment/low DO, flow alteration, and thermal modifications and the source is Tims Ford Hydro. (Note: The Elk River joins the Tennessee River upstream of Wheeler Hydro. Both states have identified this site as a low priority.)

Wheeler Hydro—Tennessee River (Alabama)

Wheeler Hydro is a TVA project located on the Tennessee River about 50 miles west of Huntsville. The pool of the reservoir extends upstream to Guntersville Hydro. There are six TMDL sites associated with Wheeler reservoir. The site with the highest State priority and the most likely to benefit from trading is Flint Creek (and possibly West Flint Creek.) The cause is organic enrichment/low DO and the sources are agricultural operations and urban runoff/storm sewers. Flint Creek has numerous tributaries with TMDL sites but they may not benefit from trading; however, Flint Creek embayment is a major embayment and could benefit significantly.

There is one TMDL site located in the reservoir (WBNAME Elk River) that has high potential to benefit from trading. The cause for the TMDL site is organic enrichment/low DO and the sources are pasture grazing and non-irrigated crop production. The other TMDL site that is on the Tennessee River is caused by thermal modification, and the sources are industrial and flow regulation/modification. This site has very little potential to benefit from trading since it is already intensely managed to meet water quality objectives.

Two creek (Mallard and Big Nance) are the TMDL sites for the last three listed sites. The causes are organic enrichment/low DO and ammonia, and the sources are agricultural nonpoint sources. There is low potential for trading to benefit these sites because the TMDL sites occur upstream from the reservoir.

Wilson Hydro—Tennessee River (Alabama)

Wilson Hydro is a TVA project located on the Tennessee River near Florence. There is one TMDL site on Town Creek, a tributary to Wilson Lake. The cause of the TMDL site is organic enrichment/low DO, and the sources are non-irrigated crop production and pasture grazing. There is low potential for lake enhancement (trading) to address the TMDL issue since the site is located upstream from the reservoir.

Pickwick Hydro—Tennessee River (Alabama)

Pickwick Hydro is a TVA project located on the Tennessee River (in the State of Tennessee) about 50 miles northwest of Florence. There is one TMDL site listed by the State of Alabama that is located on Pond Creek, and the cause is organic enrichment/low DO. The sources include non-irrigated crop production, urban runoff/storm sewers, and natural sources. There is low potential for lake enhancement (trading) to address the TMDL issue since the site is located upstream of the reservoir.

Pickwick Hydro—Tennessee River (Mississippi)

Pickwick Hydro is located on the Tennessee River in the State of Tennessee about 5 miles north of the Mississippi-Tennessee State line. There are six TMDL sites that are located on tributaries of Pickwick Reservoir. The TMDL designations are attributed to organic enrichment/low DO and nutrients. No source information was provided. The Yellow Creek site is mainly in an embayment of the reservoir and could benefit from in-lake enhancements. The other sites have low potential to benefit from in-lake enhancements because the sites are located mainly upstream from the reservoir.

Kentucky Hydro—Tennessee River (Kentucky/Tennessee)

Kentucky Hydro is a TVA project located on the Tennessee River near its confluence with the Ohio River, about 25 miles southeast of Paducah, Kentucky. The Big Sandy River enters Kentucky Reservoir about 50 miles south of (upstream from) Kentucky Hydro, and forms a large embayment. West Sandy Creek is a tributary of the Big Sandy River, and its mouth is a part of the embayment. The West Sandy embayment has two TMDL sites caused by organic enrichment/low DO and nutrients. The sources of the TMDL are an upstream impoundment, septic tanks, and recreational activities. There is good potential for in-lake enhancements to satisfy the objectives for these TMDL sites. (Note: The states of Kentucky/Tennessee have identified this site as a low priority.)

LOWER MISSISSIPPI SUB-BASIN

No candidate trading projects were identified.

MISSOURI											
DAM_NAME	**RIVER**	**NEAR_CITY**	**OWNER**	**PURPOSE**	**HYDR_HGT**	**NORM_STOR**	**SURF_AREA**	**DRAIN_AREA**	**LATITUDE**	**LONGITUDE**	**HUC NUMBER**
					FEET	**AC-FEET**	**AC**	**SQ. MI.**			
High Volume											
TABLE ROCK DAM	WHITE RIVER	BRANSON	DAEN SWL	OHRSF	225	2702000			36.595000	-93.308300	11010001
OSAGE (BAGNELL)	OSAGE	BAGNELL	UNION ELECTRIC CO	HCR		1926800	55342	14000	38.205300	-92.622500	10290109
HARRY S TRUMAN DAM	OSAGE RIVER	WARSAW, MO	DAEN MRK	HCR	98	1203404	55600	11500	38.266700	-93.401700	10290105
STOCKTON DAM	SAC RIVER	CAPLINGER MILLS, MO	DAEN MRK	CHR	153	892000	24900	1160	37.691700	-93.758300	10290106
CLARENCE CANNON DAM (MARK TWAIN)	SALT	NEW LONDON	DAEN LMS	CHR	130	543994	8400	1310	39.525000	-91.643300	07110007
LOCK & DAM NO. 26	MISSISSIPPI		MISSOURI JOINT MUNI ELEC UTIL	NHR		169443			38.900000	-90.200000	07110009
Moderate Volume											
TAUM SAUK P/S UPPER	E FK BLACK	LESTERVILLE	UNION ELECTRIC CO	H		4460	55		37.533300	-90.816700	11010007
Low Volume											
RE-REGULATION DAM (CLARENCE CANNON)	SALT RIVER	NEW LONDON, MO	DAEN LMS	HOR	31	3500	110	29	39.560000	-91.570000	07110007

Appendix 6: Priority of candidate trading projects identified in the survey of hydropower projects in the Mississippi River Basin - July, 2000

Project/State	High	Project Priority Medium	Low	Unknown
Pensacola/OK	X			
J. Percy Priest/TN	X			
Cheatham/TN	X			
Old Hickory/TN	X			
Tenkiller/OK	X			
Broken Bow/OK	X			
O'Shaughnessy/OH	X			
Weber falls L&D/OK	X			
Barkley/KT	X			
Dix/KY	X			
Keystone/OK		X		
Table Rock/MO		X		
Eaufaula/OK		X		
Harry S. Truman/MO		X		
Robert S. Kerr/OK			X	
Fort Patrick Henry/TN			X	
Fort Gibson/OK			X	
Fort Loudoun/TN			X	
Wheeler/AL			X	
Yellowtail/MT			X	
Fort Peck/MT			X	
Kaw/OK			X	
Center Hill/TN			X	
Cherokee/TN			X	
Douglas/TN			X	
Tims Ford/TN			X	
Denison/OK			X	
Canyon Ferry/MT			X	
Holter/MT			X	
Holmesville/NE			X	
Blue Springs/NE			X	
Guntersville/AL			X	
Kentucky/KY			X	
Watauga/TN			X	
Wilson/AL			X	
Pickwick/TN			X	
Prairie River/MN			X	
Brainerd/MN			X	
Eau Galle/WI			X	

Anamosa/IA	X
Waverly/IA	X
Five In One/IA	X
Iowa Falls/IA	X
Ottumwa/IA	X
Lock & Dam 19/IA	X
Dayton/IL	X
Rockton/IL	X
Dixon/IL	X
Sears/IL	X
Leclaire/IL	X
Starved Rock/IL	X
Lockport/IL*	X
South Holston/TN	X
Power/IL	X
Moline/IL	X

* Lockport Hydro is described under the Chicago Sanitation & Ship Canal Hydro.